HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

April 8, 2020

Vuzix Corporation
25 Hendrix Road Suite A
West Henrietta, NY 14586

Dear Malcolm Davidson,

Enclosed is the EMC Wireless test report for compliance testing of the Vuzix Corporation, M100 Swim Project as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), FCC Part 15 Subpart C for Intentional Radiators.

Thank you for using the services of Eurofins E&E North America. If you have any questions regarding these results or if we can be of further service to you, please feel free to contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

Michelle Tawmging

Michelle Tawmging
Documentation Department

Reference: (\Vuzix Corporation\WIR104136-FCC247 FHSS)

Electromagnetic Compatibility Criteria
Test Report

for the

Vuzix Corporation
M100 Swim Project

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart C
15.247 for Intentional Radiators

Report: WIR104136-FCC247 FHSS

April 8, 2020

Prepared For:

Vuzix Corporation
25 Hendrix Road Suite A
West Henrietta, NY 14586

Prepared By:
Eurofins E&E North America
914 W. Patapsco Avenue
Baltimore, MD 21230

Electromagnetic Compatibility Criteria
Test Report

for the

Vuzix Corporation
M100 Swim Project

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15
15.247 Subpart C for Intentional Radiators

Donald Salguero, Project Engineer
Wireless Lab

Michelle Tawmging
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Part 15.247 under normal use and maintenance.

Deepak Giri
Manager, Wireless Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	April 8, 2020	Initial Issue.

Table of Contents

List of Figures

List of Terms and Abbreviations

AC	**A**lternating **C**urrent
ACF	**A**ntenna **C**orrection **F**actor
Cal	**Cal**ibration
d	**M**easurement **D**istance
dB	**D**eci**b**els
dBµA	**D**eci**b**els above one **micro**amp
dBµV	**D**eci**b**els above one **micro**volt
dBµA/m	**D**eci**b**els above one **micro**amp **per m**eter
dBµV/m	**D**eci**b**els above one **micro**volt **per m**eter
DC	**D**irect **C**urrent
E	**E**lectric Field
DSL	**D**igital **S**ubscriber **L**ine
ESD	**E**lectro**s**tatic **D**ischarge
EUT	**E**quipment **U**nder **T**est
f	**F**requency
FCC	**F**ederal **C**ommunications **C**ommission
GRP	**G**round **R**eference **P**lane
H	Magnetic Field
HCP	**H**orizontal **C**oupling **P**lane
Hz	**H**er**z**
IEC	**I**nternational **E**lectrotechnical **C**ommission
kHz	**k**ilo**h**er**z**
kPa	**k**ilo**pa**scal
kV	**k**ilo**v**olt
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
MHz	**M**ega**h**ertz
µH	**micro**henry
µ	**micro**farad
µs	**micros**econds
NEBS	**N**etwork **E**quipment-**B**uilding **S**ystem
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
TWT	**T**raveling **W**ave **T**ube
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

Executive Summary

A. Purpose of Test

An EMC Wireless evaluation was performed to determine compliance of the Vuzix Corporation M100 Swim Project, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the M100 Swim Project. Vuzix Corporation should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the M100 Swim Project, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Vuzix Corporation, purchase order number 512581. All tests were conducted using measurement procedure ANSI C63.10-2013.

FCC Reference 47 CFR Part 15.247:2005	Description	Compliance
Title 47 of the CFR, Part 15 §15.203	Antenna Requirement	Compliance
Title 47 of the CFR, Part 15 §15.207(a)	Conducted Emission Limits	Compliance
Title 47 of the CFR, Part 15 §15.247(a)(1)	20 dB Occupied Bandwidth	Compliance
Title 47 of the CFR, Part 15 §15.247(a)(1)	Average Time of Occupancy (Dwell Time)	Compliance
Title 47 of the CFR, Part 15 §15.247(a)(1)	Number of RF Channels	Compliance
Title 47 of the CFR, Part 15 §15.247(a)(1)	RF Channel Separation	Compliance
Title 47 of the CFR, Part 15 §15.247(b)	Peak Power Output	Compliance
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	Radiated Spurious Emissions	Compliance
Title 47 of the CFR, Part 15 §15.247(d)	Spurious Conducted Emissions	Compliance
Title 47 of the CFR, Part 15 §15.247(i)	Maximum Permissible Exposure (MPE)	Compliance

Figure 1: Executive Summary of EMC Wireless Part 15.247 ComplianceTesting

Eurofins MET Laboratories Inc. (Eurofins E&E North America) is part of the Eurofins Electrical & Electronics (E&E) global compliance network.

Equipment Configuration

A. Overview

Eurofins MET Laboratories, Inc. was contracted by Vuzix Corporation to perform testing on the M100 Swim Project, under Vuzix Corporation's purchase order number 512581.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Vuzix Corporation, M100 Swim Project.

The results obtained relate only to the item(s) tested.

Model Tested:	M100 Swim Project	
Model Covered:	M100 Swim Project	
EUT Specifications:	Primary Power: 5 VDC	
	FCC ID: 2AA9D-467	
	Type of Modulations:	QPSK (DH1), π/4 DQPSK (2-DH1), 8 DPSK (3-DH1)
	Equipment Code:	DSS
	RF Output Power:	2.631 dBm
	EUT Frequency Ranges:	2402 – 2480 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35º C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Donald Salguero	
Report Date:	April 8, 2020	

Figure 2: EUT Summary Table

B. References

CFR 47, Part 15, Subpart C	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Figure 3: References

C. Test Site

All testing was performed at Eurofins MET Laboratories, Inc., 914 W. Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

Eurofins MET Laboratories Inc. (Eurofins E&E North America) is part of the Eurofins Electrical & Electronics (E&E) global compliance network.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty	K	Confidence Level
RF Frequencies	±4.52 Hz	2	95%
RF Power Conducted Emissions	±2.32 dB	2	95%
RF Power Conducted Spurious Emissions	±2.25 dB	2	95%
RF Power Radiated Emissions	±3.01 dB	2	95%

Figure 4: Uncertainty Calculations Summary

E. Description of Test Sample

The Vuzix Corporation M100 Swim Project, Equipment Under Test (EUT), is a smart wearable display that allows users to time swimming laps and track progress in open water swims via GPS.

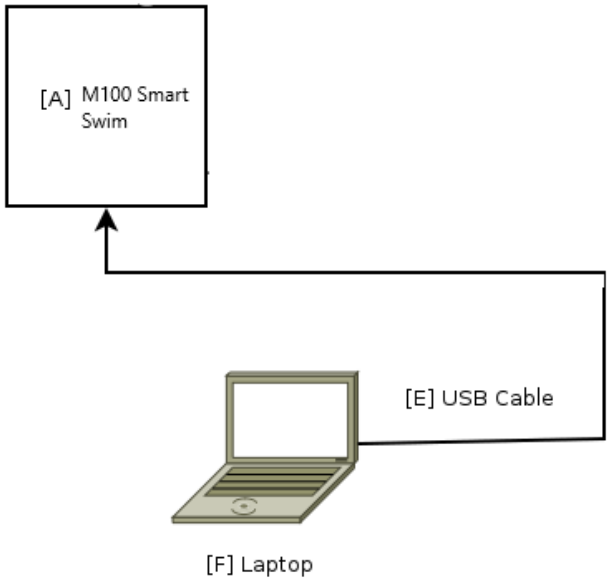

Figure 5: Block Diagram of Test Configuration

F. Equipment Configuration

The EUT was set up as outlined in Figure 5. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
A	1	Smart Swim		467T00011	M001008005	
A	2	Smart Swim		467T00011	M001008007	
A	3	Smart Swim		467T00011	conducted	

Figure 6: Equipment Configuration

G. Support Equipment

Laptop was used as a support equipment to execute test software.

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
1	USB Cable	USB-A to USB uB	1				

Figure 7: Ports and Cabling Information

I. Mode of Operation

Non-Wireless Test Mode: The Smart Swim M100 will operate all of its non-wireless peripheral functions including: battery charging, magnetic, accelerometer, gyroscope sensors, and video display via a test application that once started will operate indefinitely.

Bluetooth Test Mode: The M100 will be configurable to continuously transmit in either normal mode or hop mode via a test application.

WiFi Test Mode: The M100 will be configurable to continuously transmit with modulation applied with the ability to change channels as well as changing between B, G, and N Modes via a test application.

EUT Software (internal to EUT): M100 Android RC0
Support Software (used by support PC to exercise EUT): adb/test script for wireless

J. Method of Monitoring EUT Operation

1: The unit will continue to show the display.
2: Any other condition or sensor readout saying FAIL.

K. Modifications

a) Modifications to EUT
No modifications were made to the EUT.

b) Modifications to Test Standard
No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Vuzix Corporation upon completion of testing.

Electromagnetic Compatibility Criteria for Intentional Radiators

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.203 Antenna Requirement

Test Requirement: **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

Test Results: The EUT was **compliant** to the requirement(s) of this section. Antenna is permanently attached and is located inside enclosure.

Test Engineer: Deepak Giri

Test Date: February 3, 2020

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.207(a) Conducted Emissions Limits

Test Requirement(s): **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Σ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	§ 15.207(a), Conducted Limit (dBμV)	
	Quasi-Peak	Average
* 0.15 - 0.5	66 - 56	56 - 46
0.5 - 5	56	46
5 - 30	60	50

Figure 8: Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)

Note: *Decreases with the logarithm of the frequency.

Test Procedure: The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2014 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

Test Results: The EUT was **compliant** to the requirement(s) of this section. No anomalies noted.

Test Engineer: Deepak Giri

Test Date: January 24, 2020

Conducted Emissions Limits Test Setup

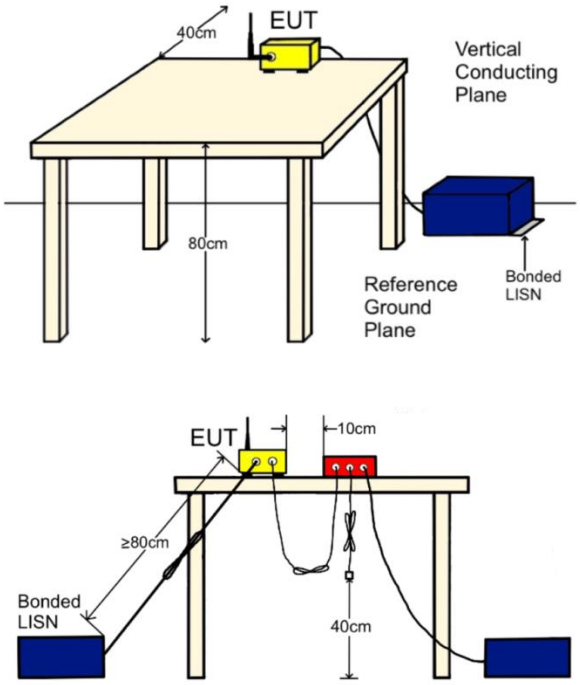

Figure 9: CEV Test Setup

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) Avg.	Limit (dBuV) Avg.	Pass/ Fail Avg.	Margin (dB) Avg.
0.161	43.44	0	10	53.44	65.41	PASS	-11.97	22.03	32.03	55.41	PASS	-23.38
0.224	40.78	0	10	50.78	62.67	PASS	-11.89	17.16	27.16	52.67	PASS	-25.51
0.323	40.13	0	10	50.13	59.63	PASS	-9.5	14.38	24.38	49.63	PASS	-25.25
0.678	35.64	0	10	45.64	56	PASS	-10.36	11.69	21.69	46	PASS	-24.31
1.09	30.11	0	10	40.11	56	PASS	-15.89	10.88	20.88	46	PASS	-25.12
2.15	21.2	0	10	31.2	56	PASS	-24.8	13.12	23.12	46	PASS	-22.88

Figure 10: Conducted Emissions, Phase Line, Test Results

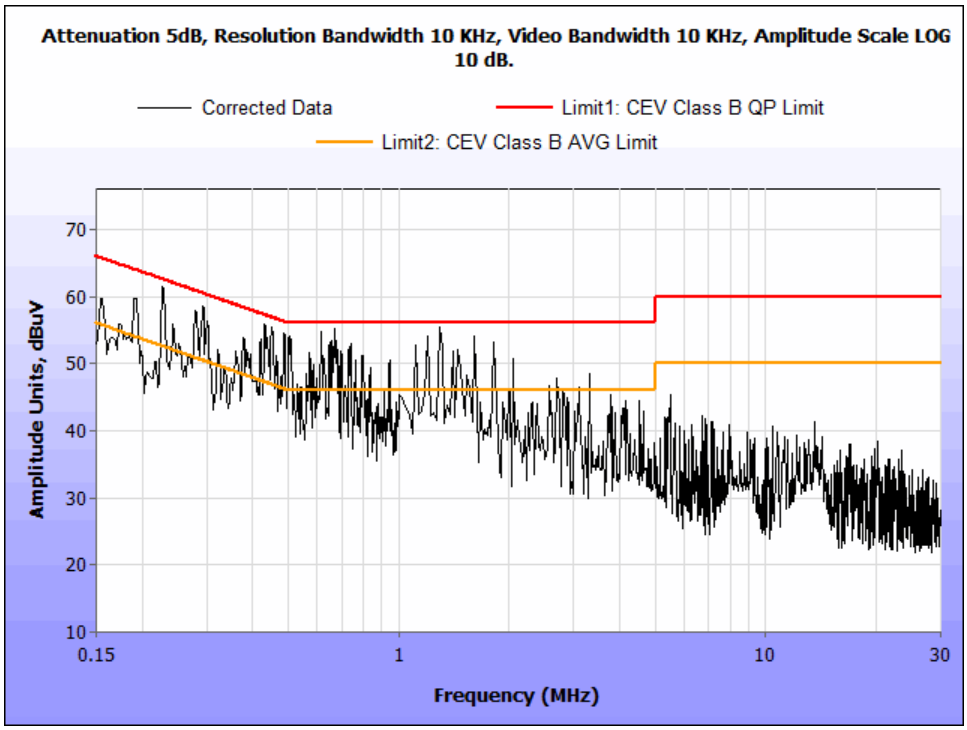

Figure 11: Conducted Emissions, Phase Line, Prescan

Frequency (MHz)	Uncorrected Meter Reading (dBuV) QP	Cable Loss (dB)	Corrected Measurement (dBuV) QP	Limit (dBuV) QP	Pass/ Fail QP	Margin (dB) QP	Uncorrected Meter Reading (dBuV) Avg.	Cable Loss (dB)	Corrected Measurement (dBuV) Avg.	Limit (dBuV) Avg.	Pass/ Fail Avg.	Margin (dB) Avg.
0.151	38.48	0	48.48	65.95	PASS	-17.47	24.66	0	34.66	55.95	PASS	-21.29
0.266	24.75	0	34.75	61.24	PASS	-26.49	11.95	0	21.95	51.24	PASS	-29.29
0.5	26.88	0	36.88	56	PASS	-19.12	22.11	0	32.11	46	PASS	-13.89
4.7	18.56	0	28.56	56	PASS	-27.44	9.8	0	19.8	46	PASS	-26.2
8.32	21.74	0	31.74	60	PASS	-28.26	11.62	0	21.62	50	PASS	-28.38
14.35	16.96	0.02	26.98	60	PASS	-33.02	11.13	0.02	21.15	50	PASS	-28.85

Figure 12: Conducted Emissions, Neutral Line, Test Results

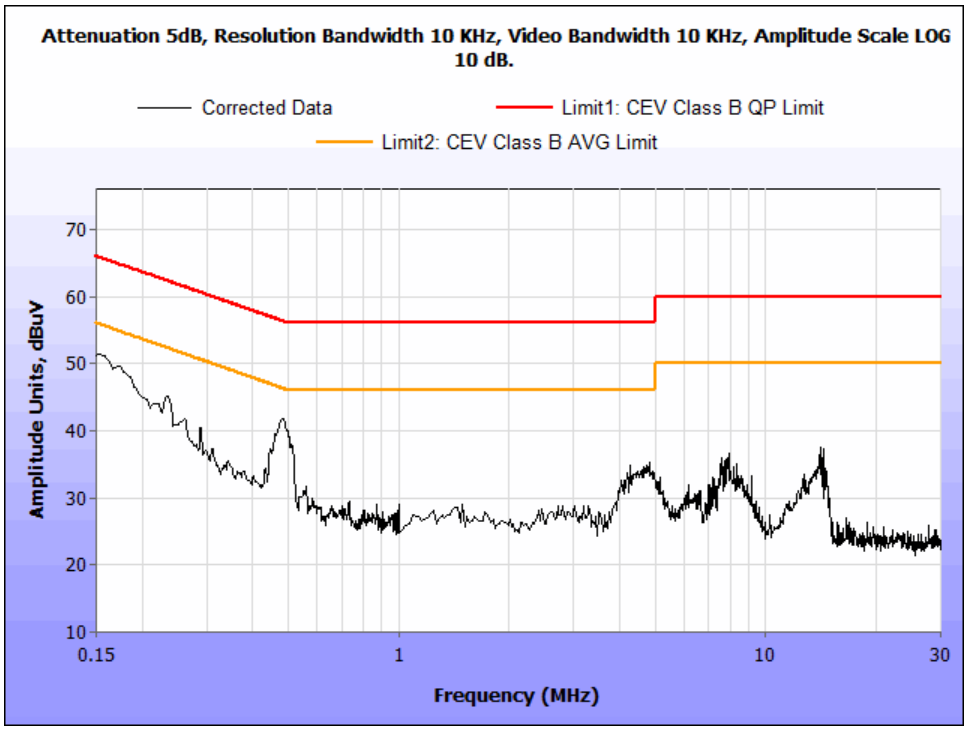

Figure 13: Conducted Emissions, Neutral Line, Prescan

Figure 14: Conducted Emissions, Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(a)(1) 20 dB Occupied Bandwidth

Test Requirements: **§ 15.247(a):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Procedure: The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1-5% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

Test Results: The EUT was **compliant** to the requirement(s) of this section. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: March 23, 2020

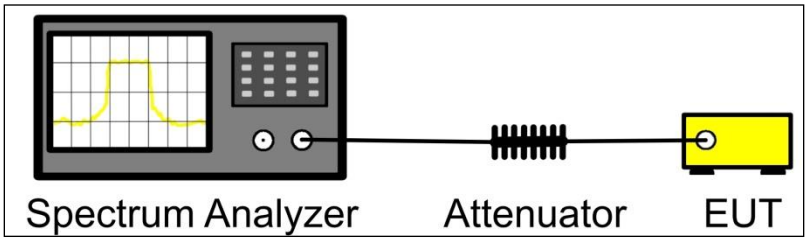

Figure 15: 99% Bandwidth Test Setup

Mode	Center Frequency (MHz)	99% Bandwidth (kHz)	20dB BW (kHz)
DH1	2402	837.9937	896.508
	2441	842.1477	900.089
	2480	843.6403	898.833
2-DH1	2402	1154.3	1238
	2441	1144	1239
	2480	1143.3	1234
3-DH1	2402	1181.6	1251
	2441	1169.3	1252
	2480	1165	1261

Figure 16: Operating Bandwidth, Test Data

20 dB Occupied Bandwidth Test Results

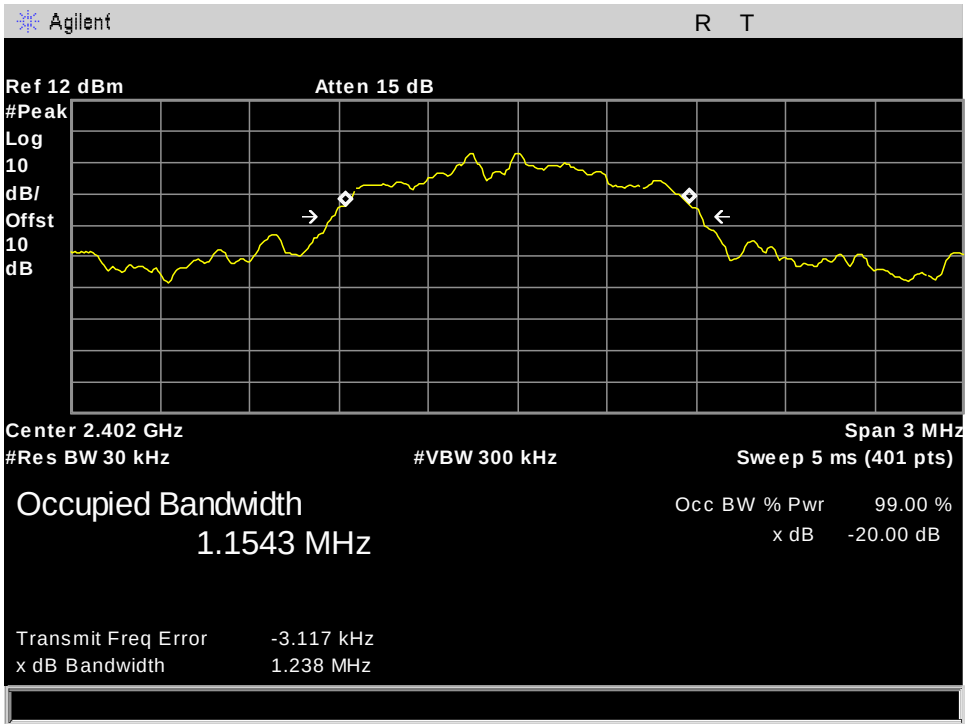

Figure 17: 20dB-99% Bandwidth, 2-DH1_2402MHz

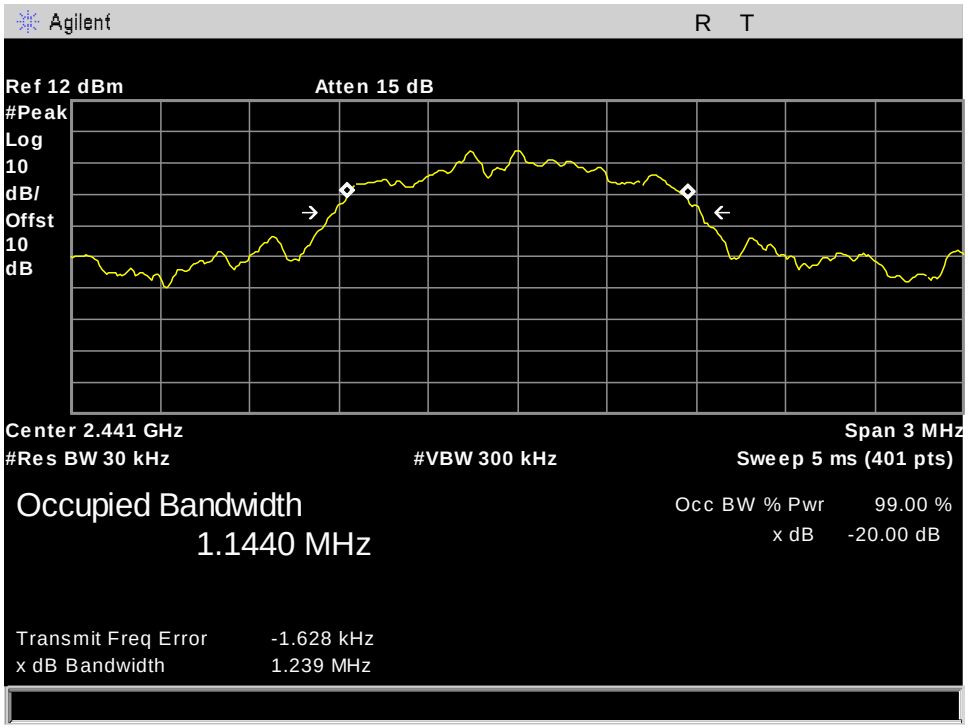

Figure 18: 20dB-99% Bandwidth, 2-DH1_2441MHz

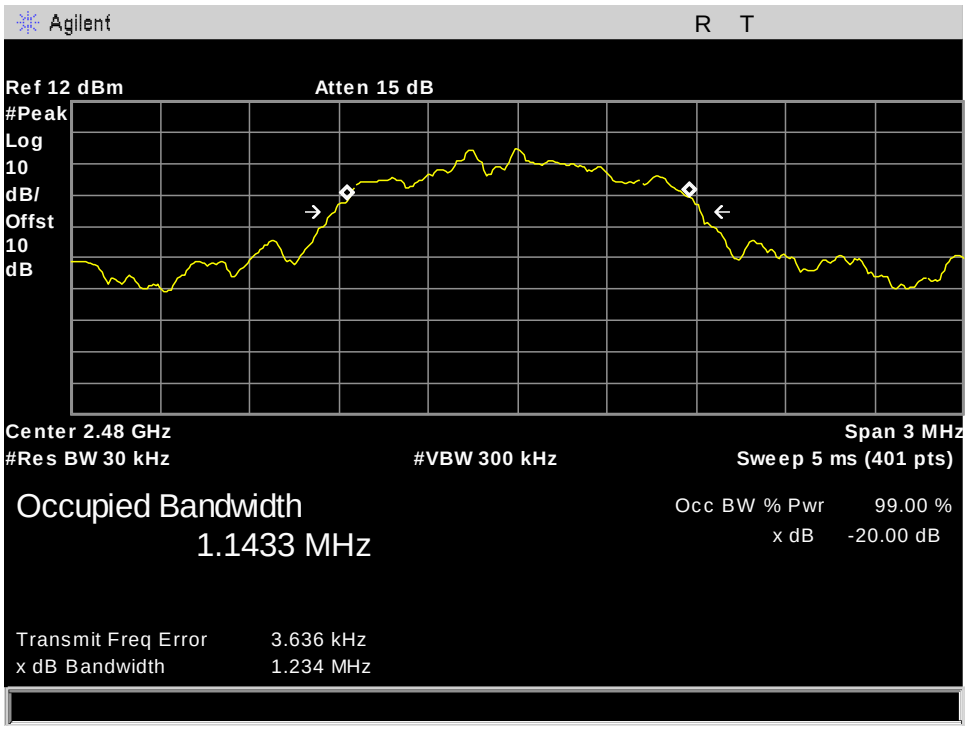

Figure 19: 20dB-99% Bandwidth, 2-DH1_2480MHz

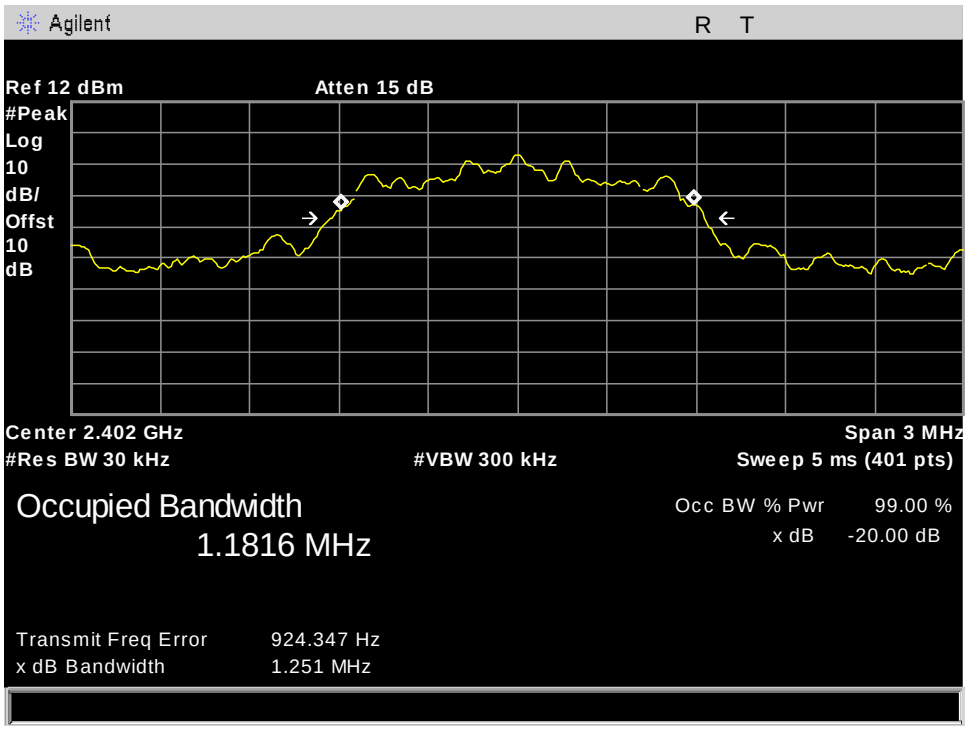

Figure 20: 20dB-99% Bandwidth, 3-DH1_2402MHz

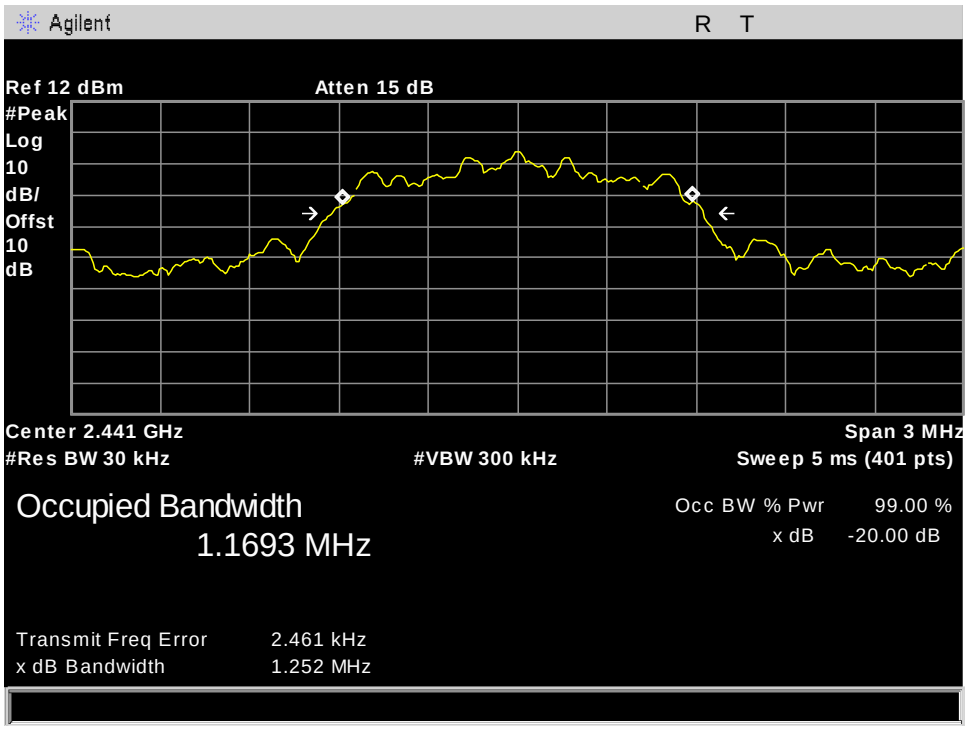

Figure 21: 20dB-99% Bandwidth, 3-DH1_2441MHz

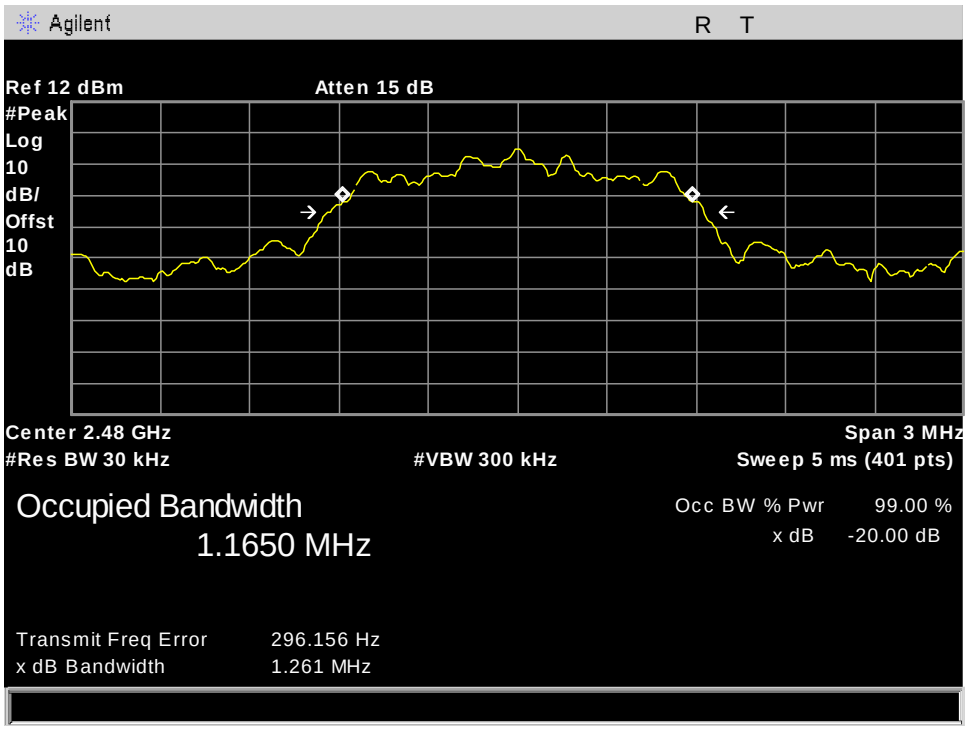

Figure 22: 20dB-99% Bandwidth, 3-DH1_2480MHz

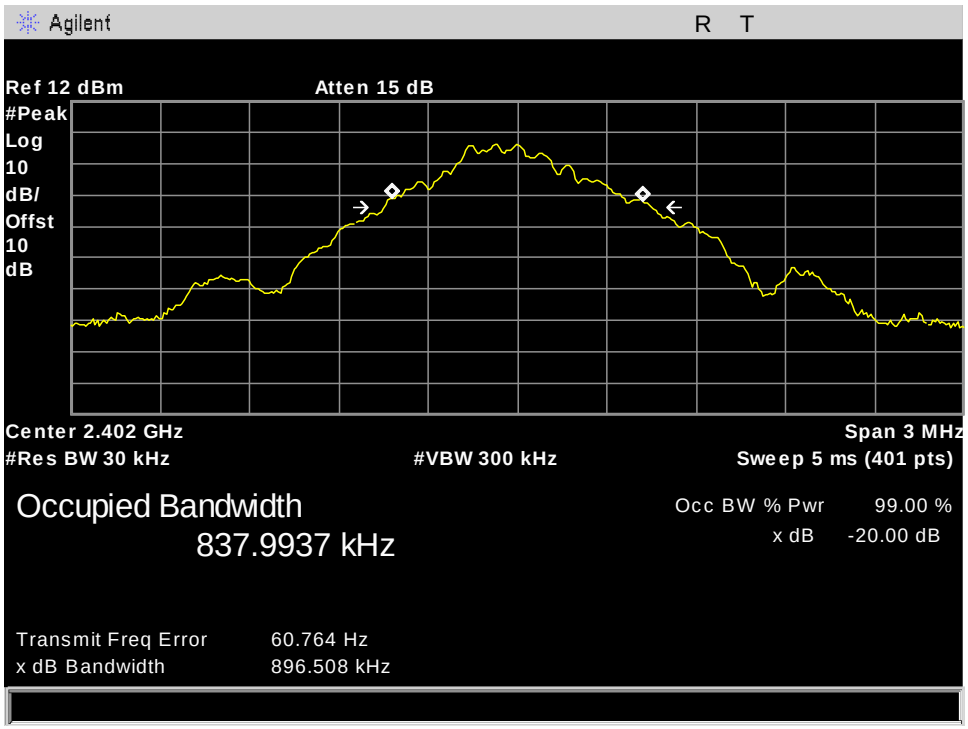

Figure 23: 20dB-99% Bandwidth, DH1_2402MHz

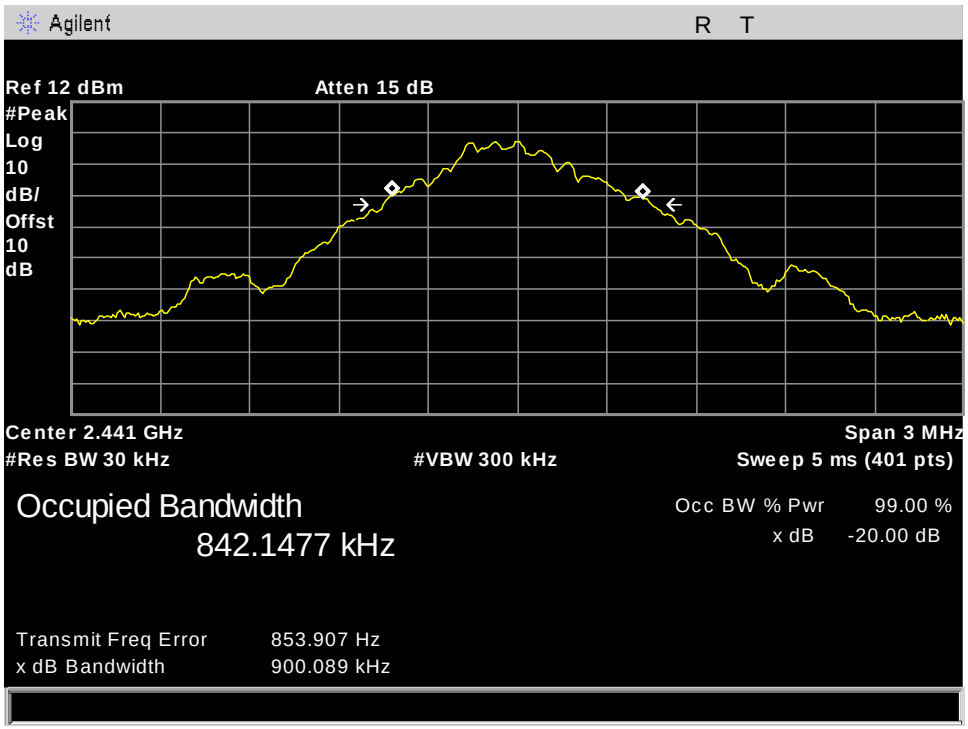

Figure 24: 20dB-99% Bandwidth, DH1_2441MHz

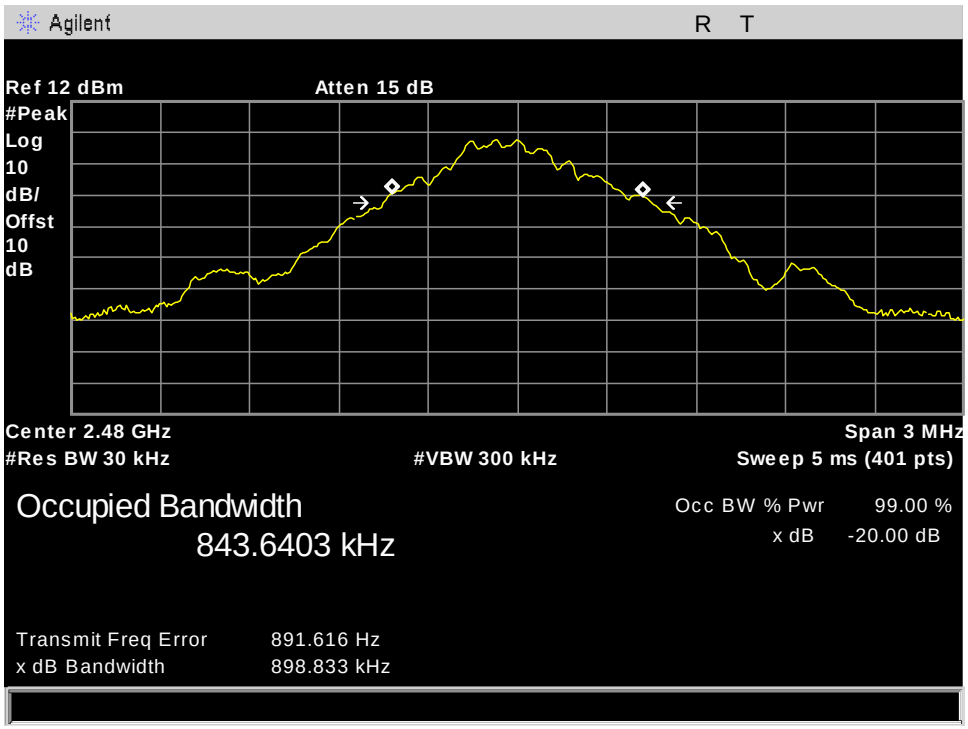

Figure 25: 20dB-99% Bandwidth, DH1_2480MHz

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(a)(1) Average Time of Occupancy (Dwell Time)

Test Requirements: (iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.4 from ANSI C63.10 – 2013 was used to compute the unit's dwell time.

Test Results The EUT was compliant with § 15.247 (a)(1)(iii). No anomalies detected.

Test Engineer: Donald Salguero

Test Date: March 23, 2020

Dwell Time								
Mode	**Frequency Range (MHZ)**	**No. of Channels**	**Hopping Period (s)**	**No. of Burst per 2s**	**Burst duration (s)**	**Dwell Time (s)**	**Limit (s)**	**Margin**
DH1	2402-2480	79	31.6	20	0.000390	0.12324	0.4	-0.27676
2-DH1	2402-2480	79	31.6	20	0.000390	0.12324	0.4	-0.27676
3-DH1	2402-2480	79	31.6	20	0.000385	0.12166	0.4	-0.27834

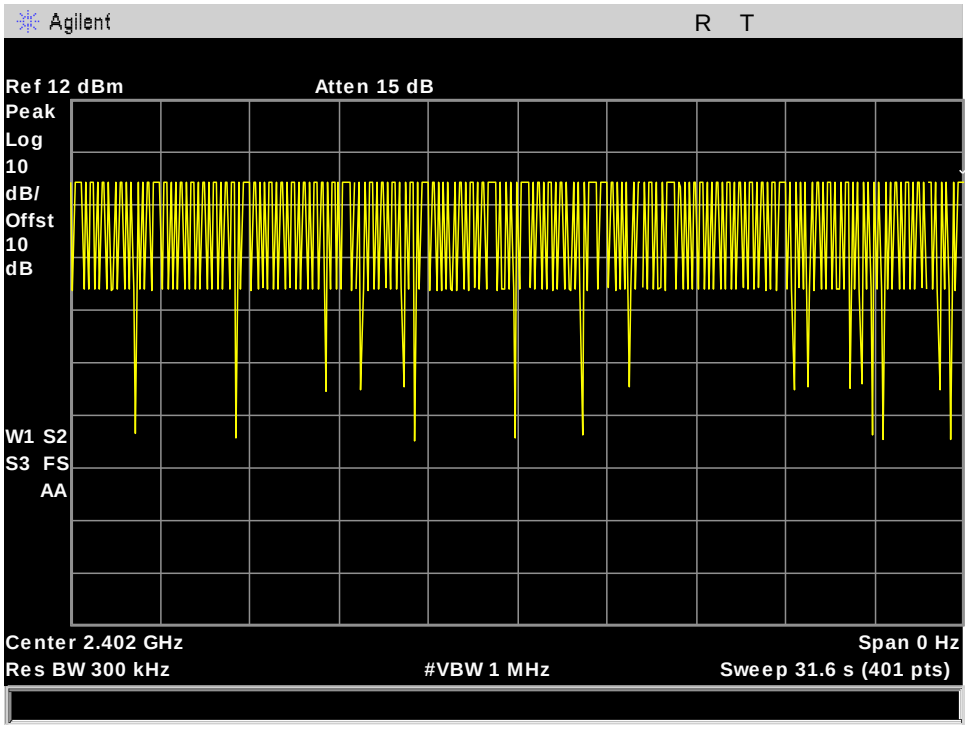

Figure 26: Average Time of Occupancy (Dwell Time), 2-DH1_dwell time

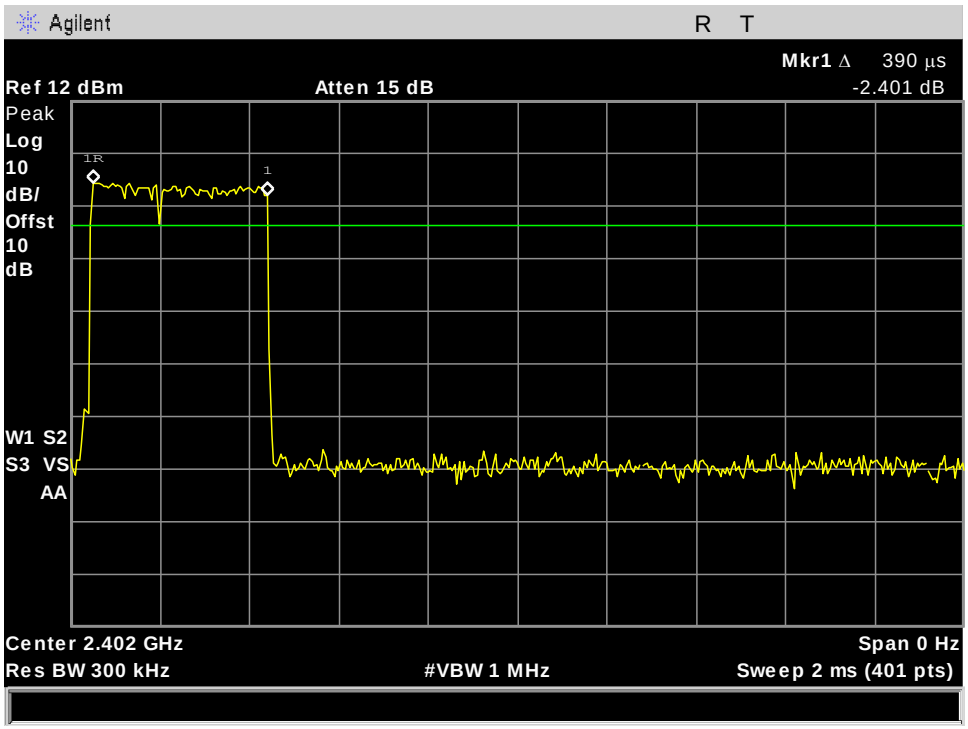

Figure 27: Average Time of Occupancy (Dwell Time), 2-DH1_pulse width

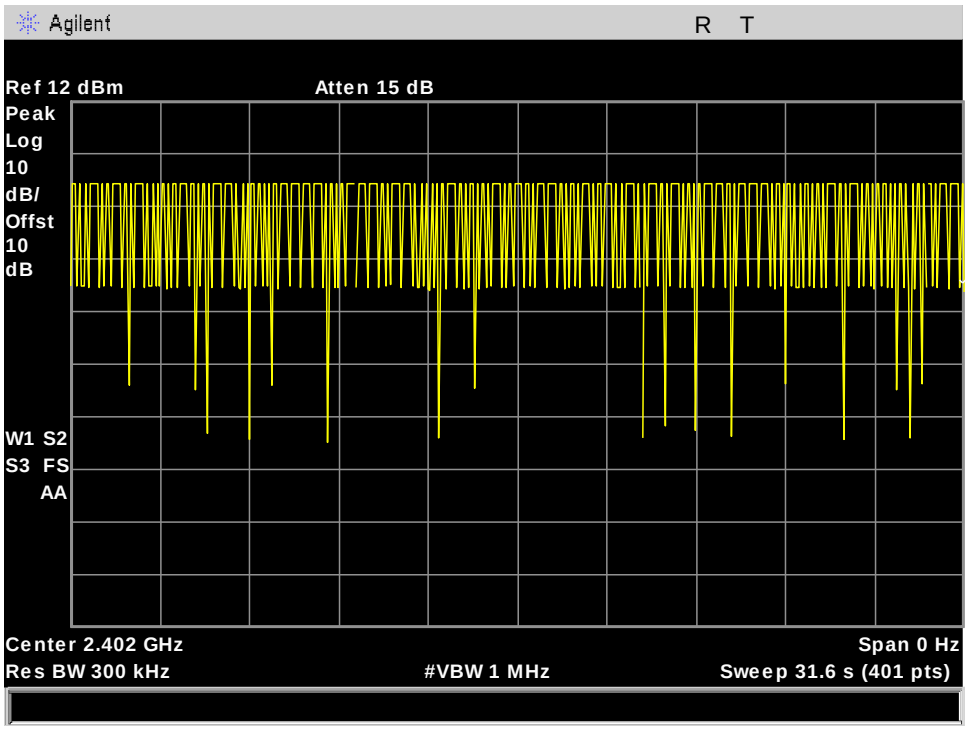

Figure 28: Average Time of Occupancy (Dwell Time), 3-DH1_dwell time

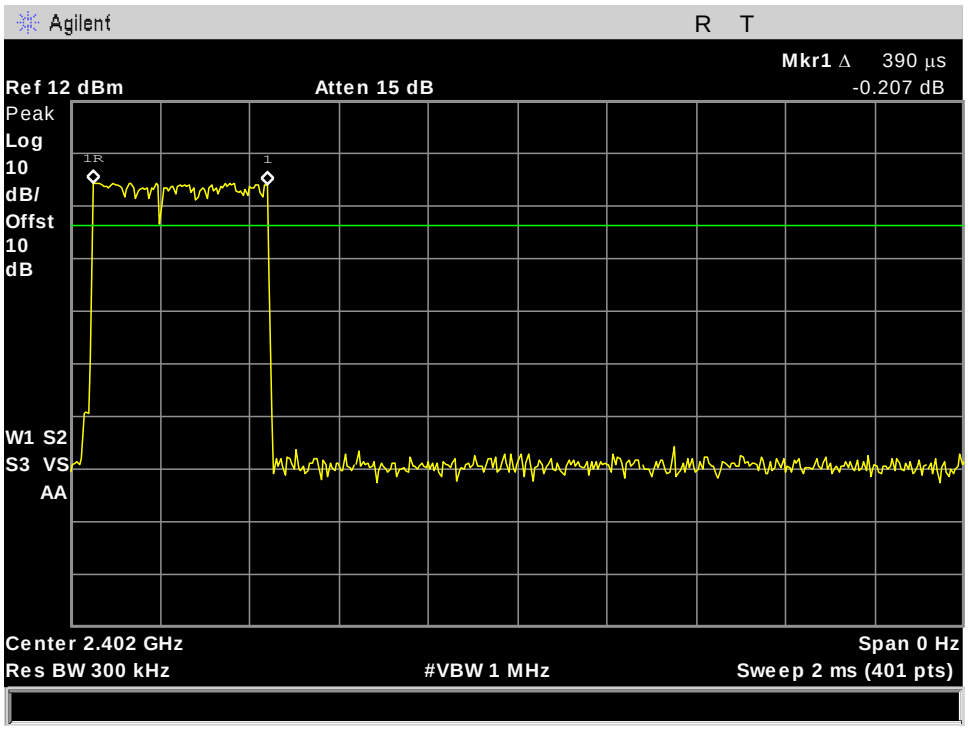

Figure 29: Average Time of Occupancy (Dwell Time), 3-DH1_pulse width

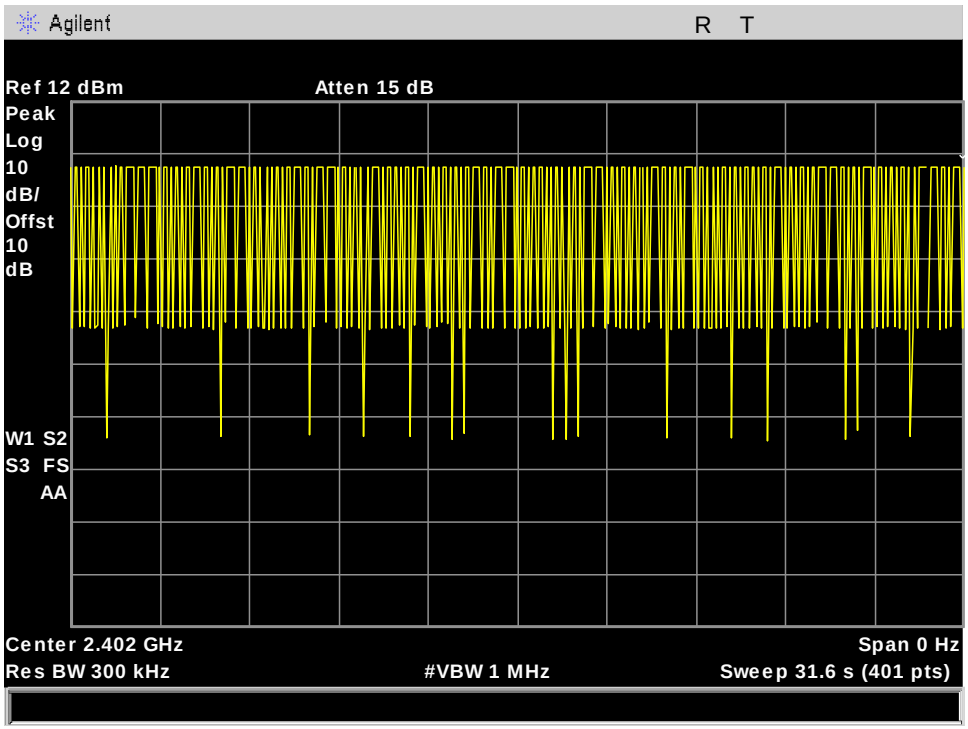

Figure 30: Average Time of Occupancy (Dwell Time), DH1_dwell time

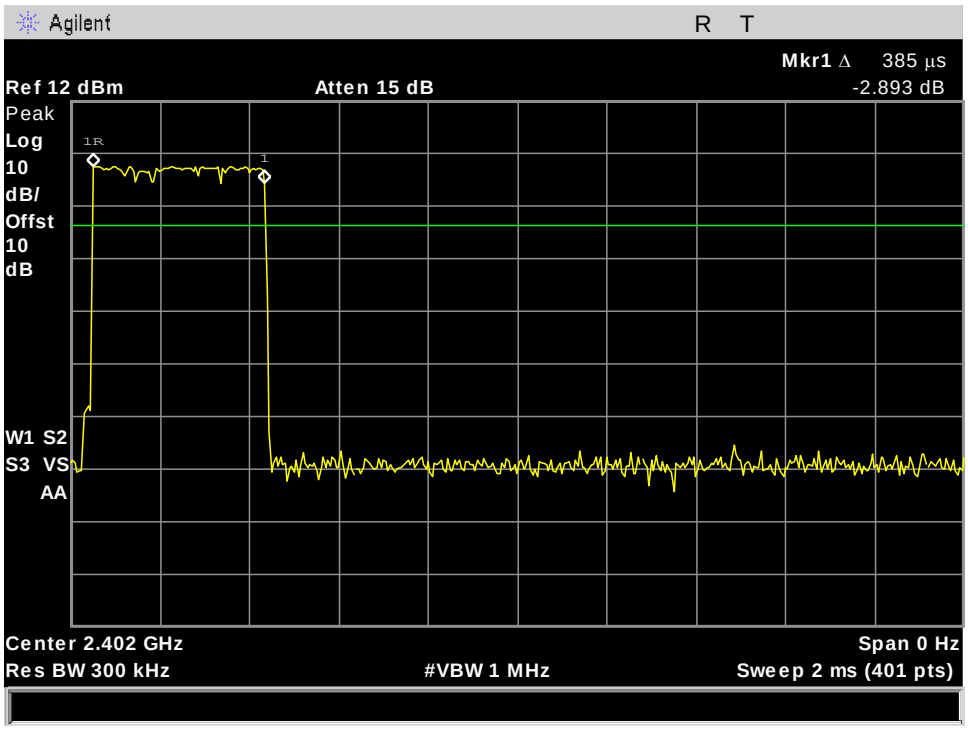

Figure 31: Average Time of Occupancy (Dwell Time), DH1_pulse width

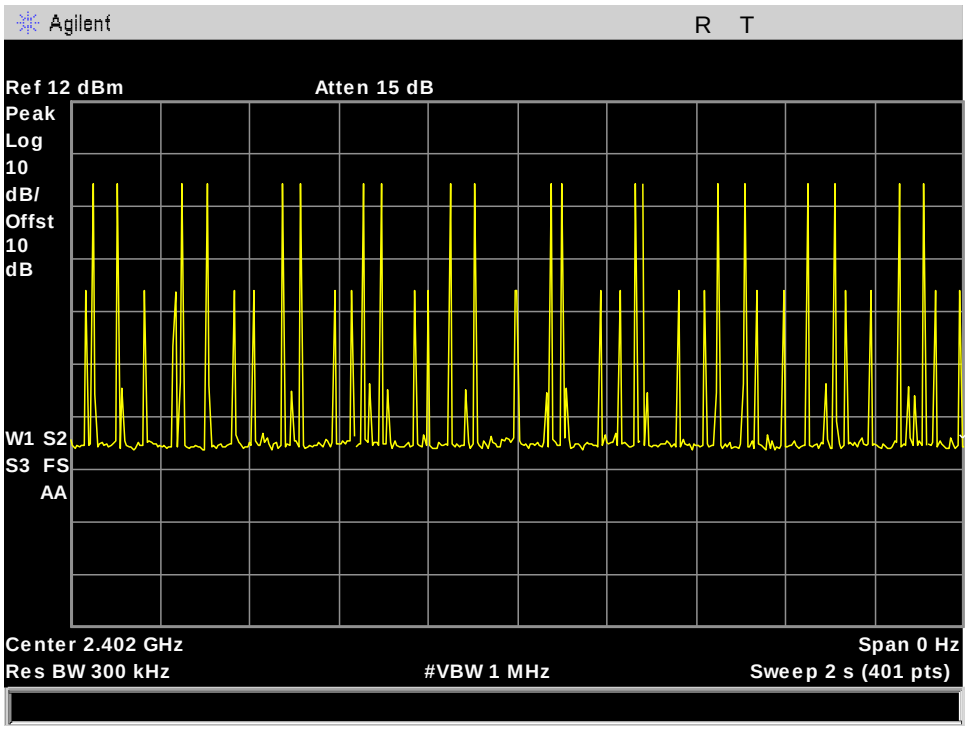

Figure 32: Average Time of Occupancy (Dwell Time), 2-DH1_2s sweep

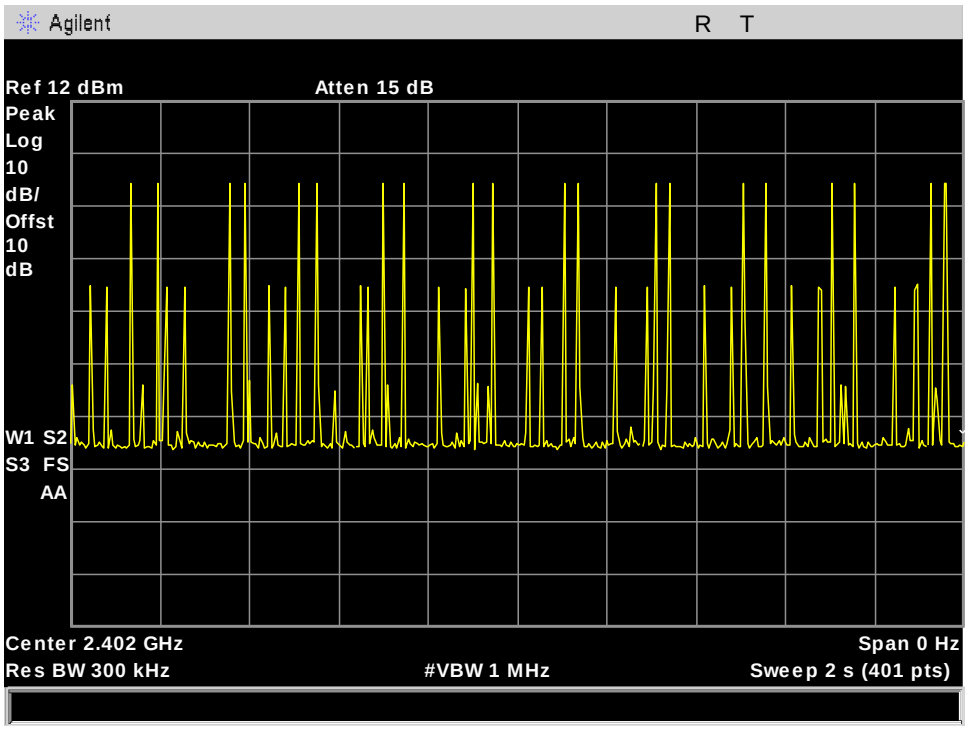

Figure 33: Average Time of Occupancy (Dwell Time), 3-DH1_2s sweep

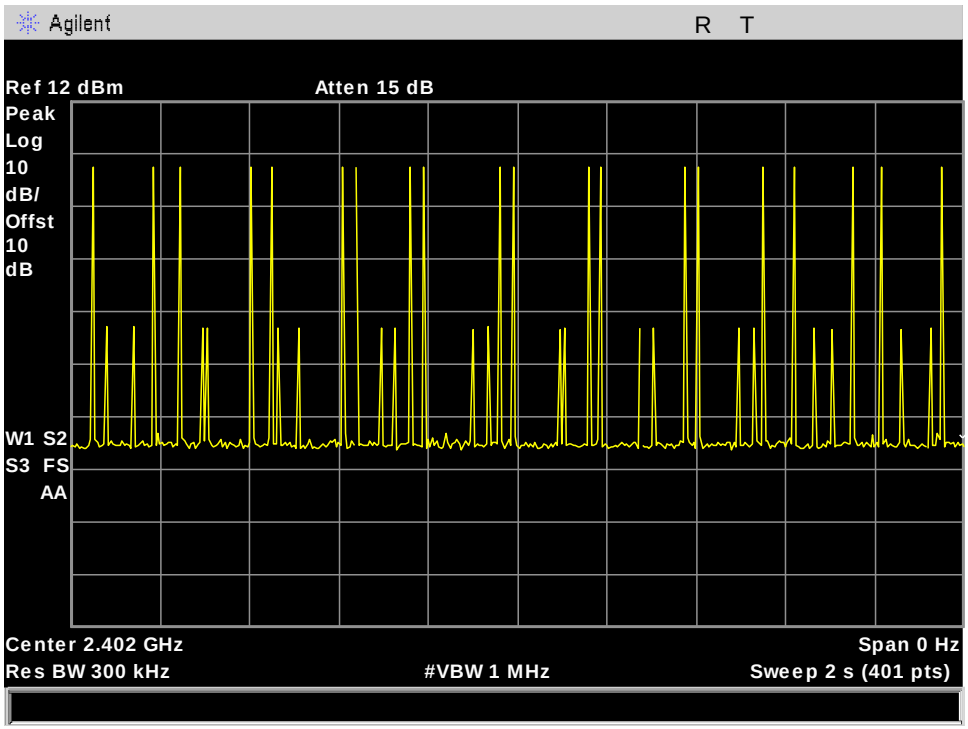

Figure 34: Average Time of Occupancy (Dwell Time), DH1_2s sweep

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(a)(1) Number of RF Channels

Test Requirements: (i) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Procedure: The EUT had its hopping function enabled. Procedure 7.8.3 from ANSI C63.10 – 2013 was used to count the number of hopping channels.

Test Results The EUT was compliant with § 15.247 (a)(1)(i). No anomalies detected.

Test Engineer: Donald Salguero

Test Date: March 23, 2020

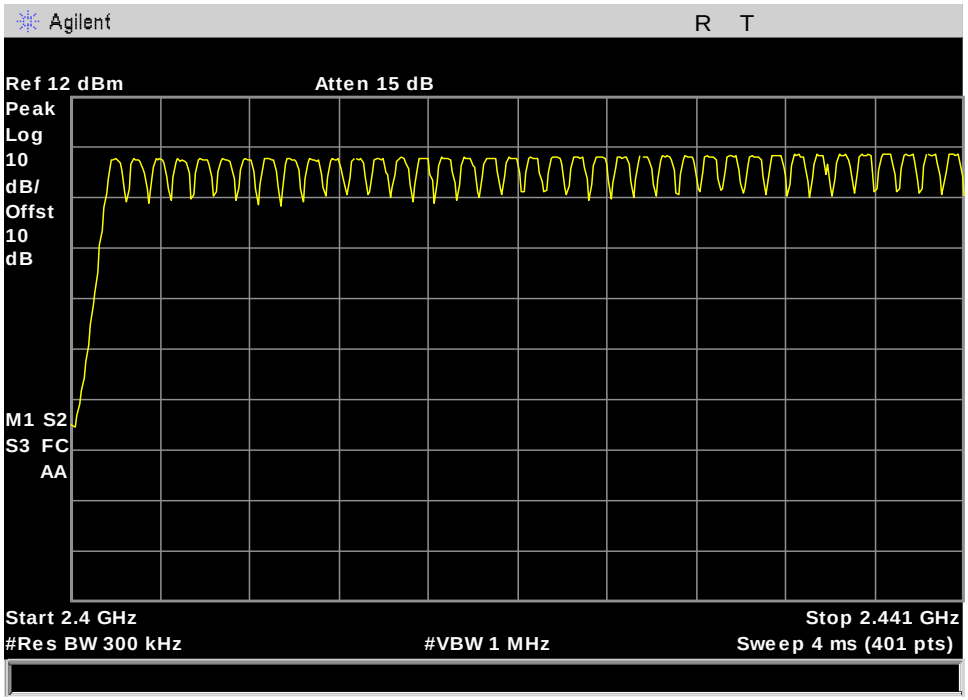

Figure 35: Number of RF Channels 1 of 2

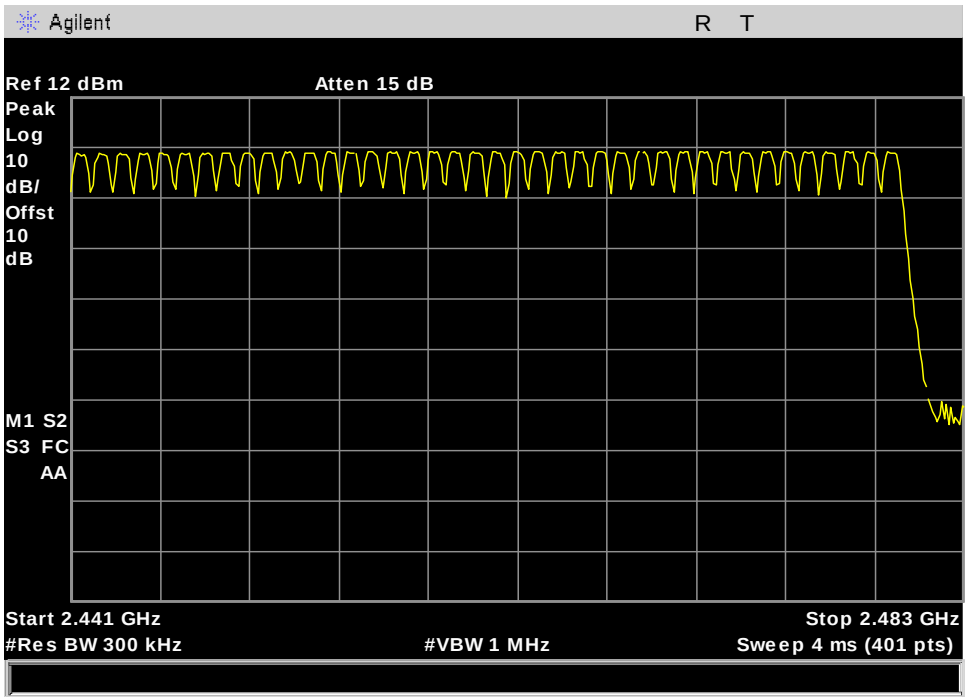

Figure 36: Number of RF Channels 2 of 2

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(a)(1) RF Channel Separation

Requirement: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Procedure: The EUT had its hopping function enabled. Procedure 7.8.2 from ANSI C63.10 – 2013 was used to measure the channel separation.

Test Results The EUT was compliant with § 15.247 (a)(1). No anomalies detected.

EUT operates below 125mW (21dBm). Channels are separated by more than two thirds of the -20dB Bandwidth.

DH1 – 2/3 *0.900 MHz (20dB Bandwidth) = 600 kHz Minimum Separation Distance
2-DH1 – 2/3 *1.239 MHz (20dB Bandwidth) = 826 kHz Minimum Separation Distance
3-DH1 – 2/3 *1.261 MHz (20dB Bandwidth) = 841 kHz Minimum Separation Distance

Test Engineer: Donald Salguero

Test Date: October 5, 2018

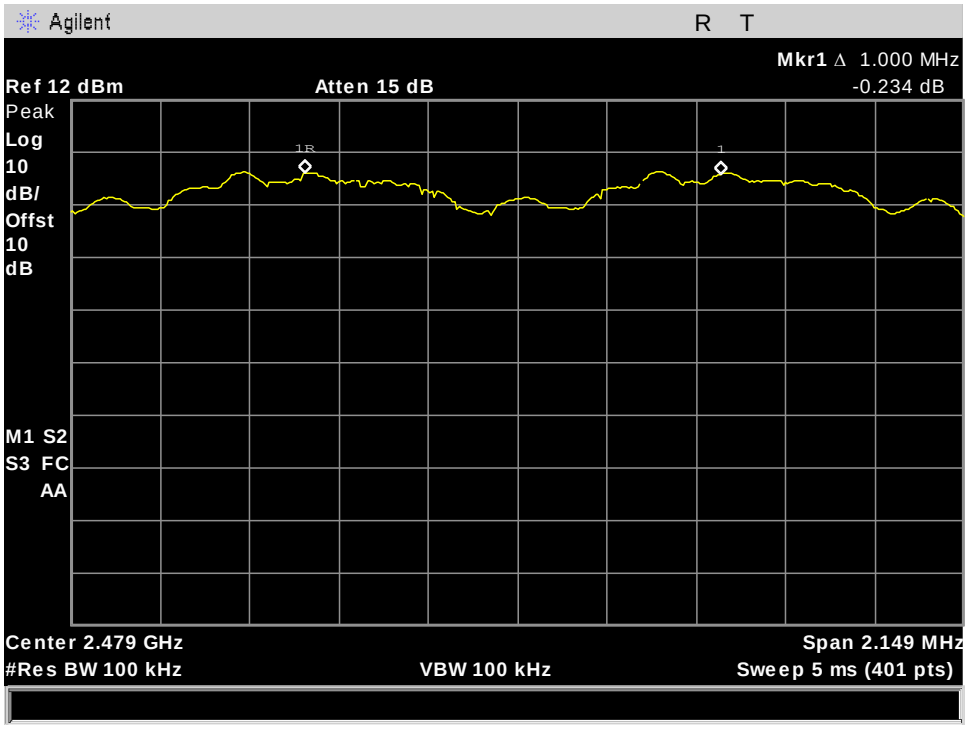

Figure 37: RF Channel Separation, 2-DH1_high channel separation

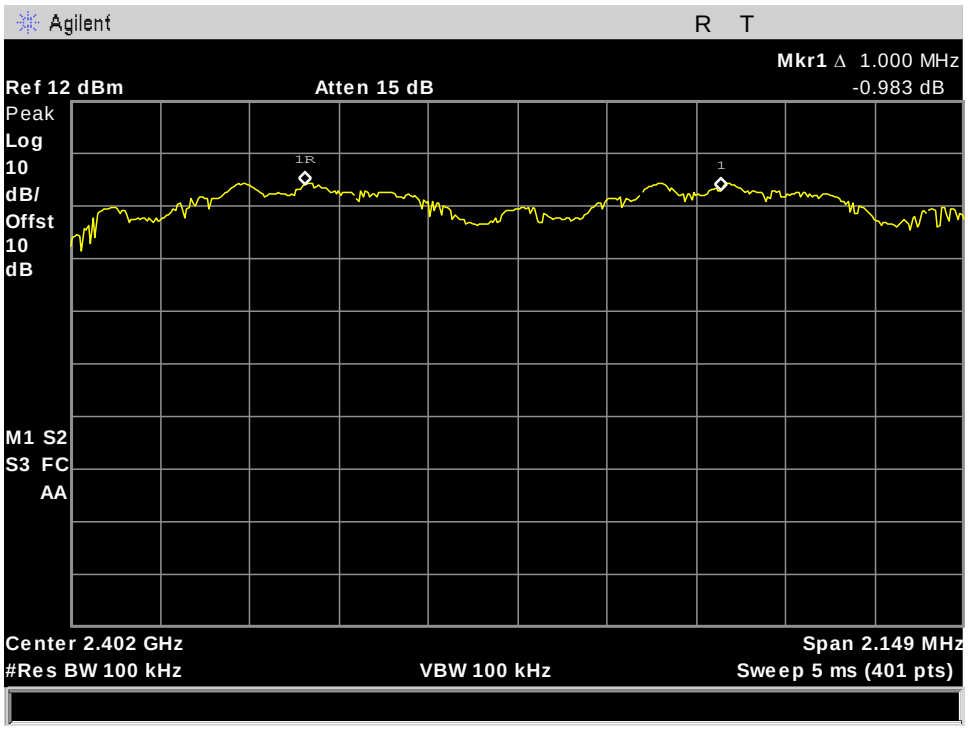

Figure 38: RF Channel Separation, 2-DH1_low channel separation

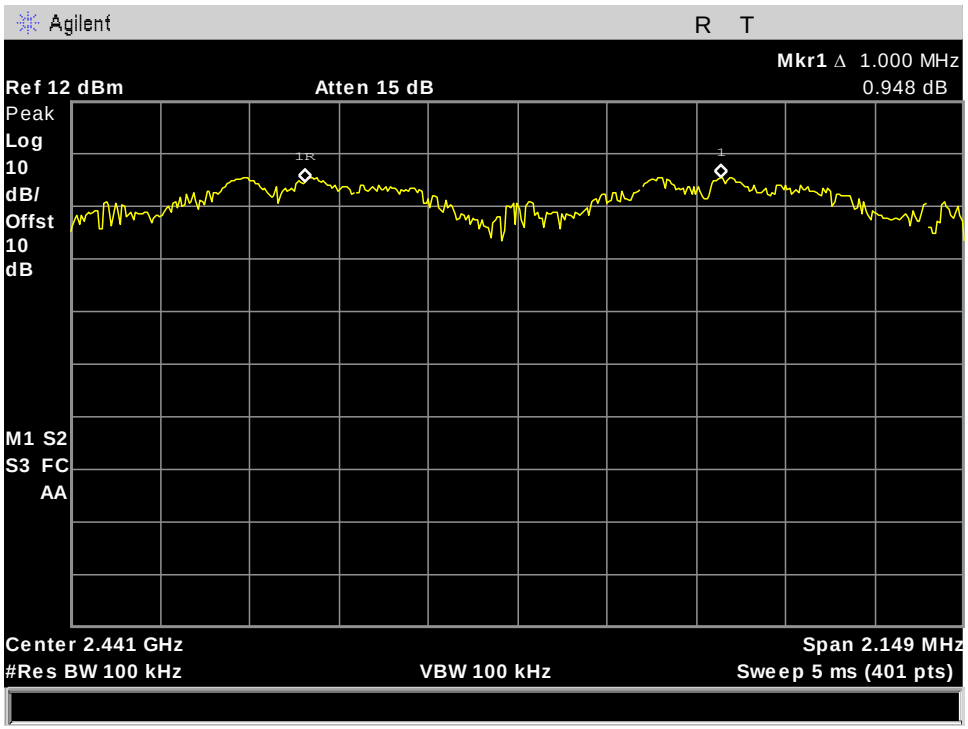

Figure 39: RF Channel Separation, 2-DH1_mid channel separation

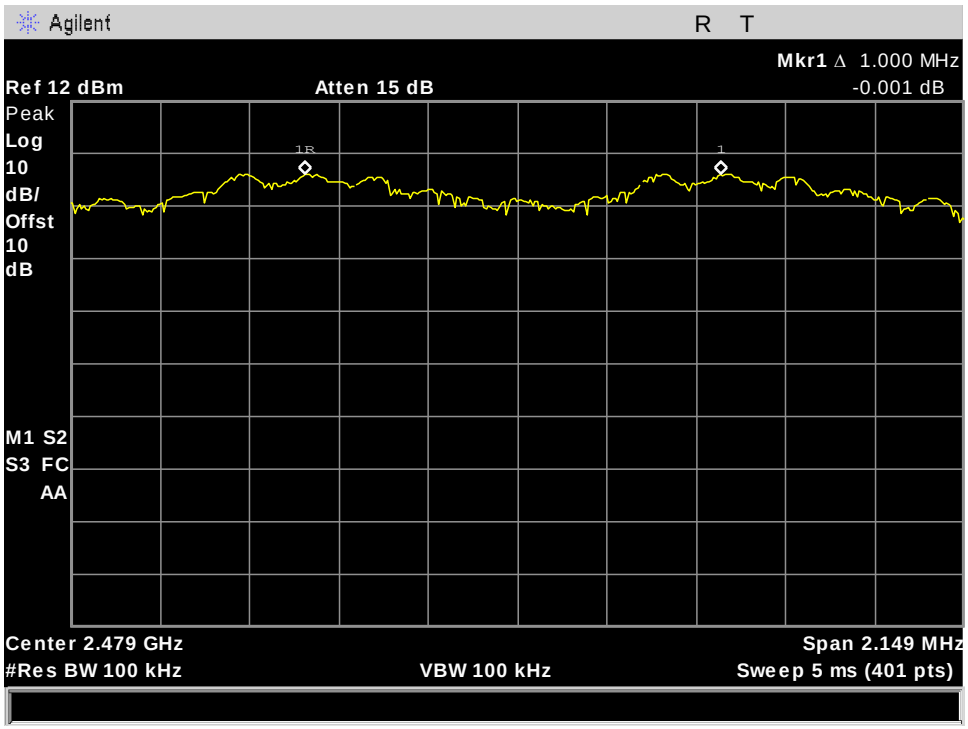

Figure 40: RF Channel Separation, 3-DH1_high channel separation

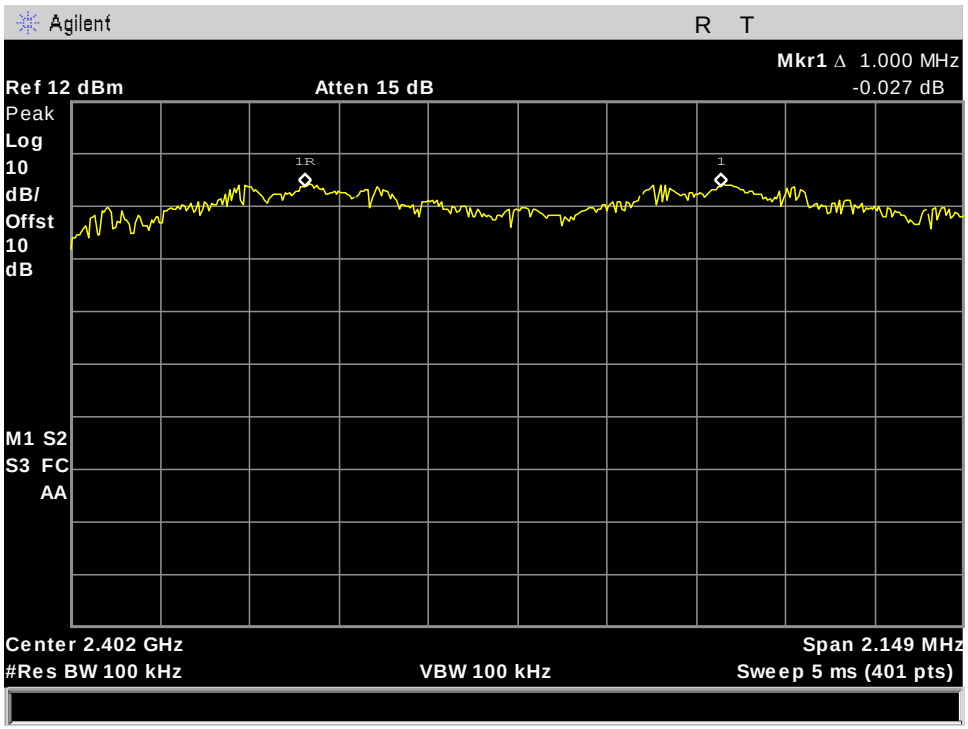

Figure 41: RF Channel Separation, 3-DH1_low channel separation

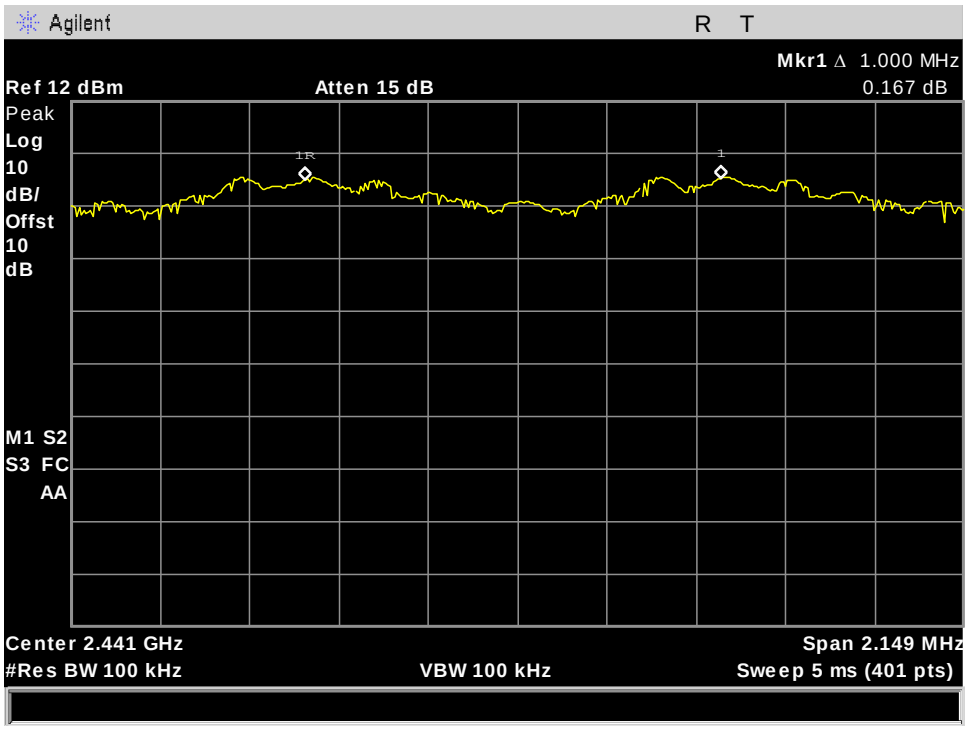

Figure 42: RF Channel Separation, 3-DH1_mid channel separation

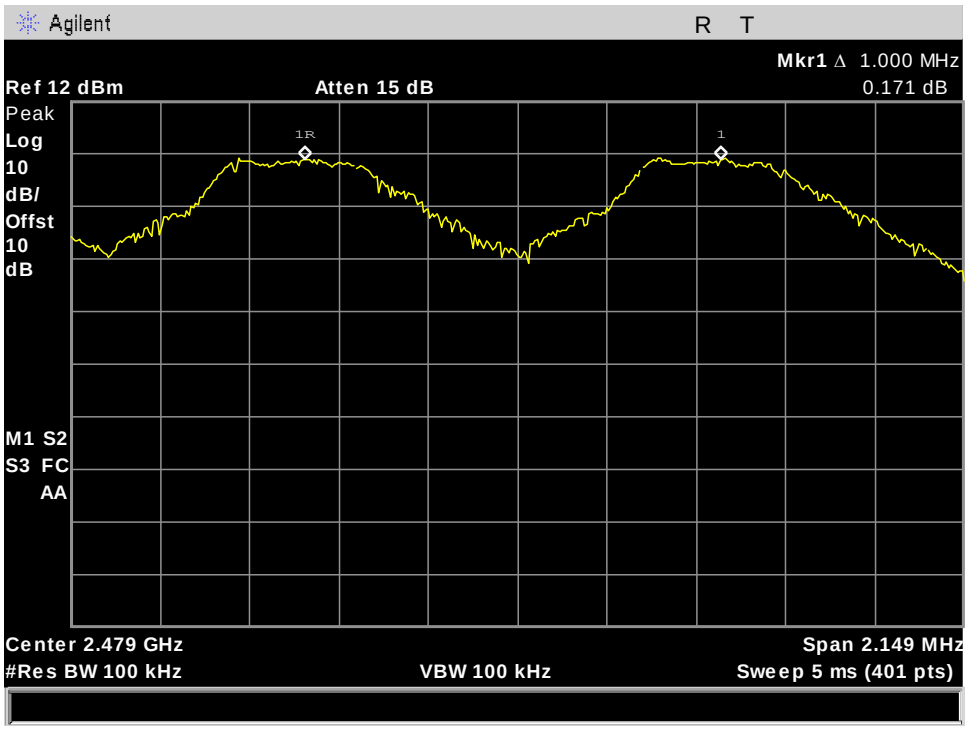

Figure 43: RF Channel Separation, DH1_high channel separation

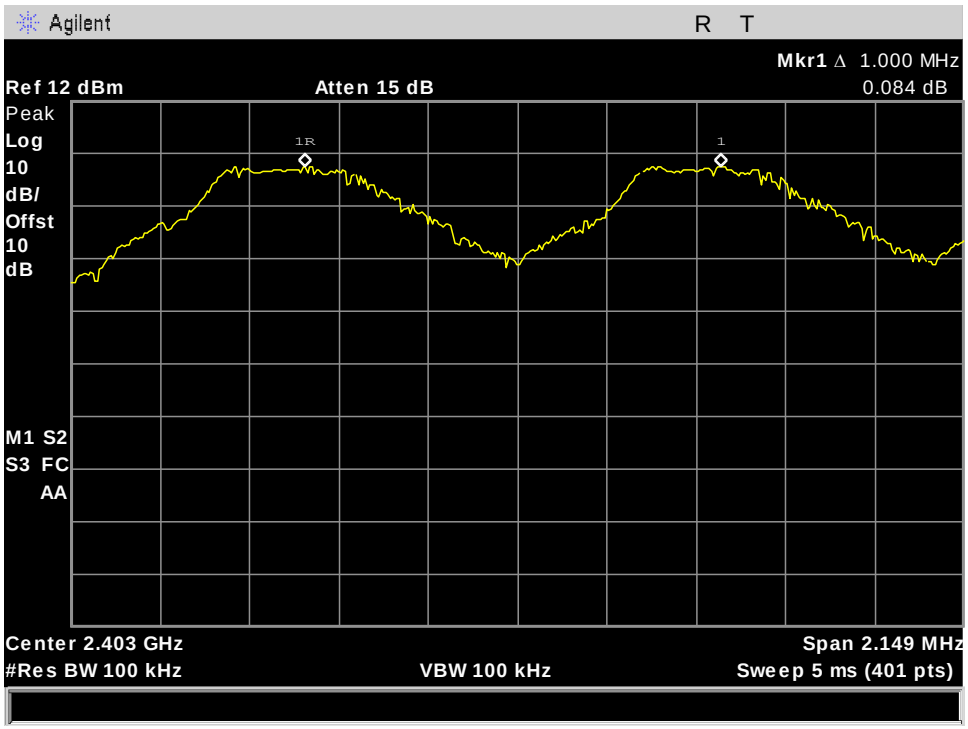

Figure 44: RF Channel Separation, DH1_low channel separation

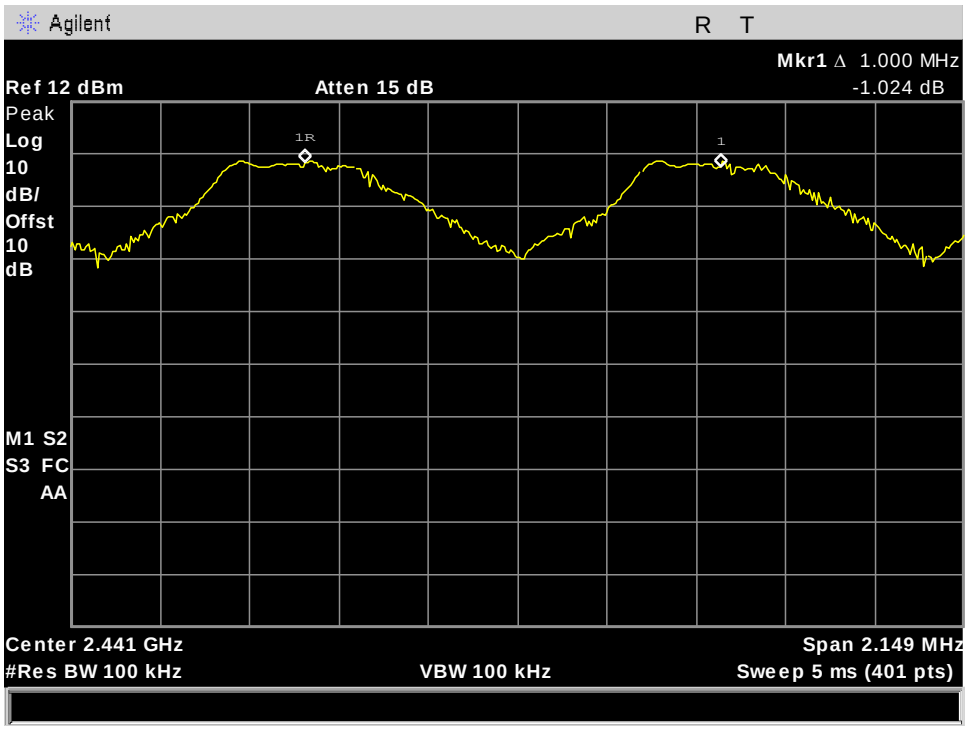

Figure 45: RF Channel Separation, DH1_mid channel separation

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(b) Peak Power Output

Test Requirements: **§15.247(b)(1):** For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

§15.247(c): if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 5725 – 5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

Test Procedure: The transmitter was connected to a calibrated spectrum analyzer. The EUT was measured at the low, mid and high channels of each band. The EUT was set up to transmit continuously at max power. The procedure from ANSI c63.10-2013 section 7.8.5 was followed to measure the peak power.

Test Results: The EUT was **compliant** to the requirement(s) of this section. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: March 25, 2020

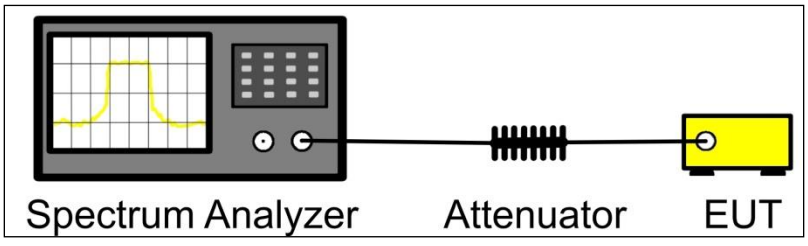

Figure 46: Power Output Test Setup

Mode	Center Frequency (MHz)	Peak Power (dBm)	Antenna Gain (dBi)	Limit (dBm)	Margin (dB)
DH1	2402	0.272	0	21	-20.728
	2441	1.488	0	21	-19.512
	2480	1.925	0	21	-19.075
2-DH1	2402	0.295	0	21	-20.705
	2441	1.463	0	21	-19.537
	2480	1.864	0	21	-19.136
3-DH1	2402	1.289	0	21	-19.711
	2441	2.495	0	21	-18.505
	2480	2.631	0	21	-18.369

Figure 47: Peak Power Output, Test Results

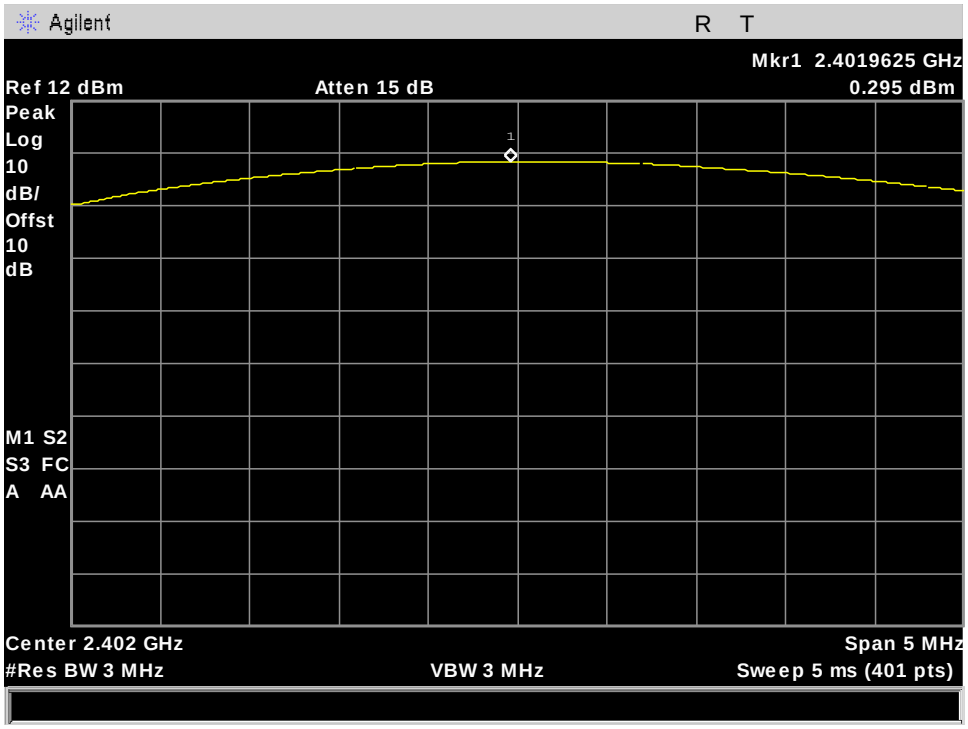

Figure 48: Peak Power Output, 2-DH1_2402

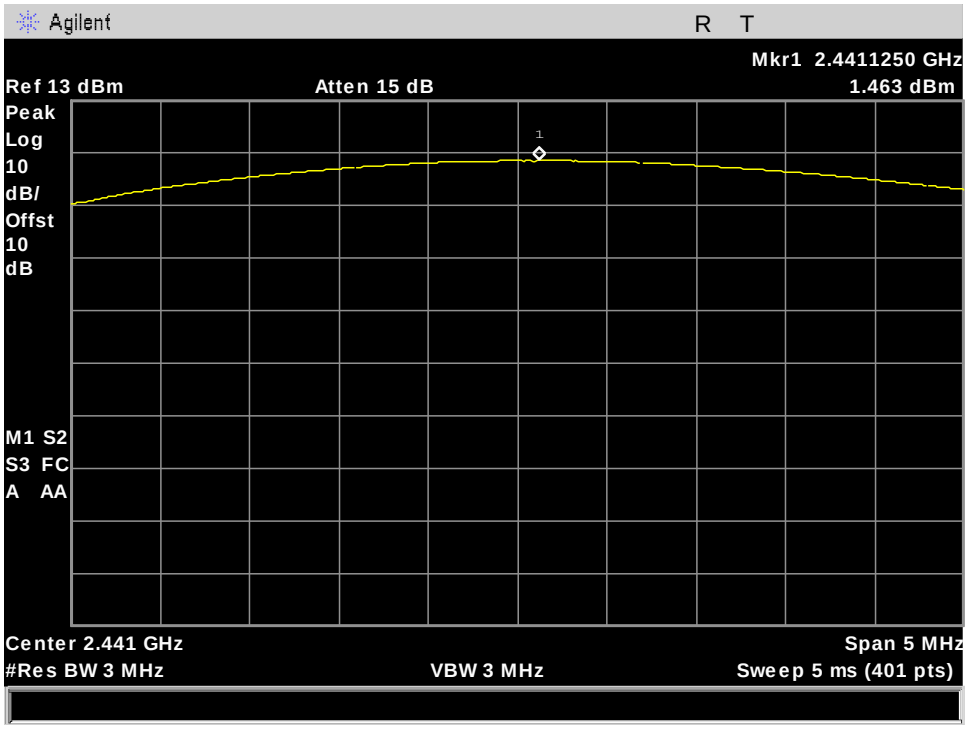

Figure 49: Peak Power Output, 2-DH1_2441

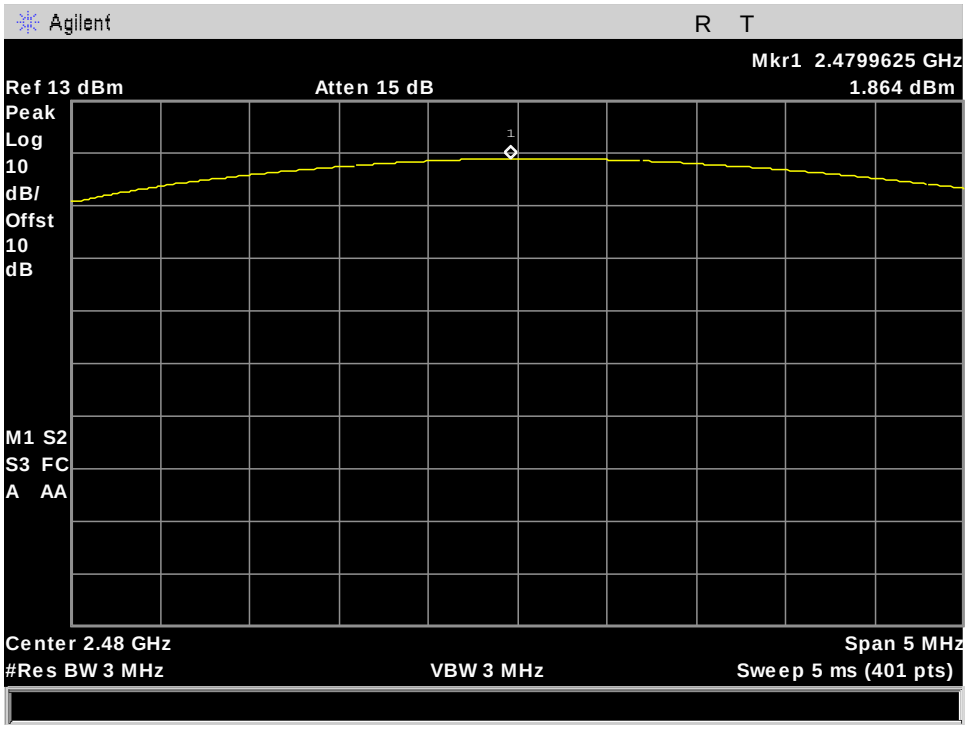

Figure 50: Peak Power Output, 2-DH1_2480

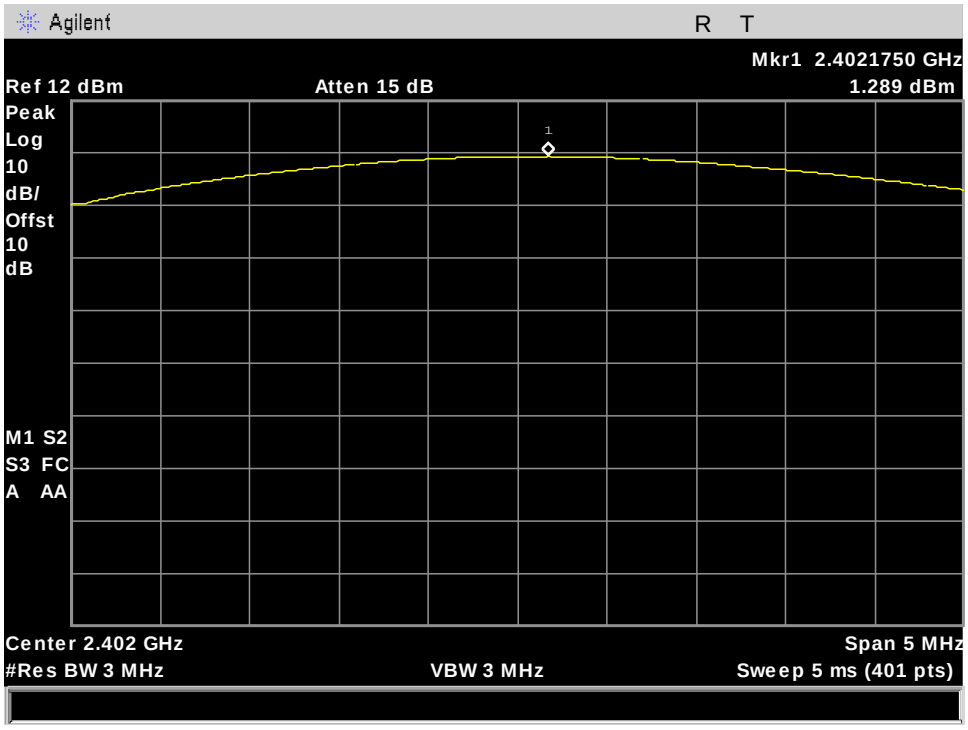

Figure 51: Peak Power Output, 3-DH1_2402

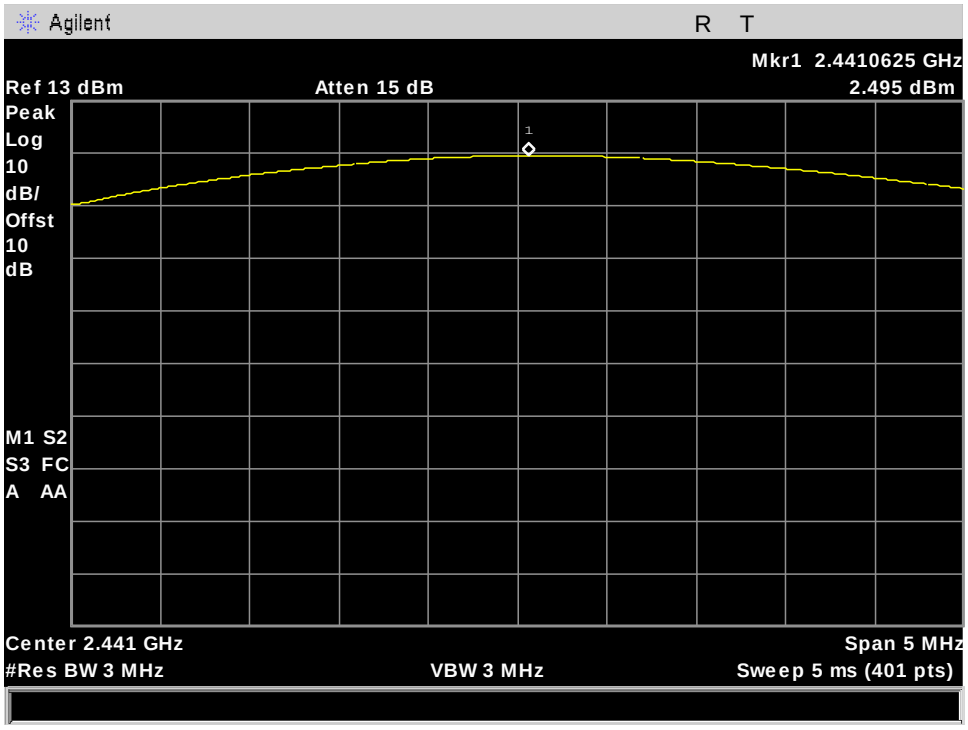

Figure 52: Peak Power Output, 3-DH1_2441

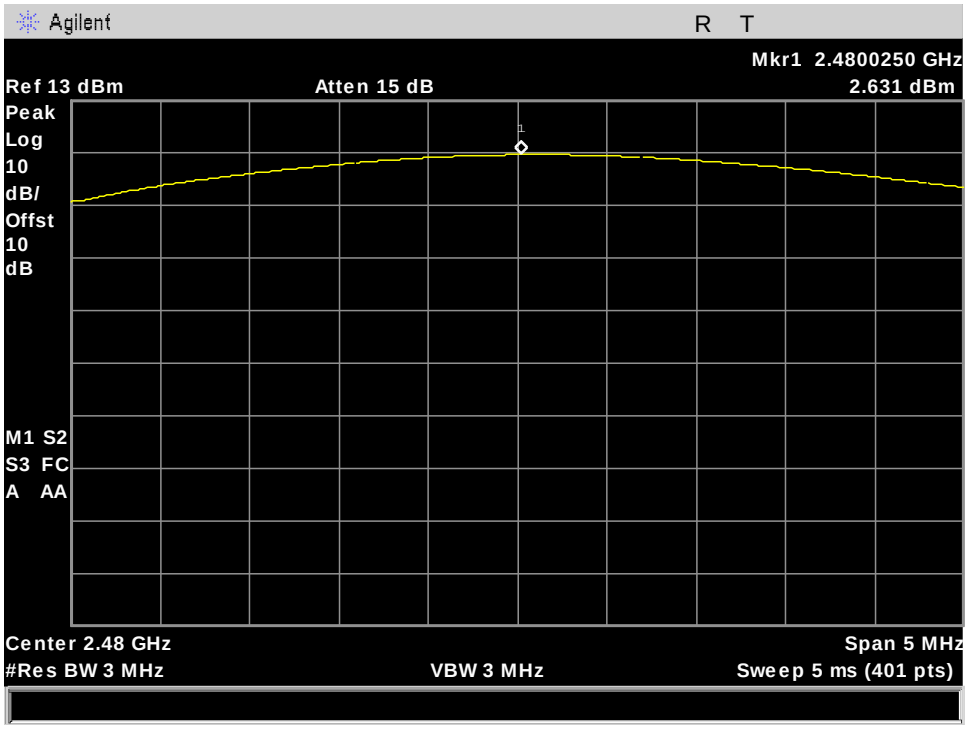

Figure 53: Peak Power Output, 3-DH1_2480

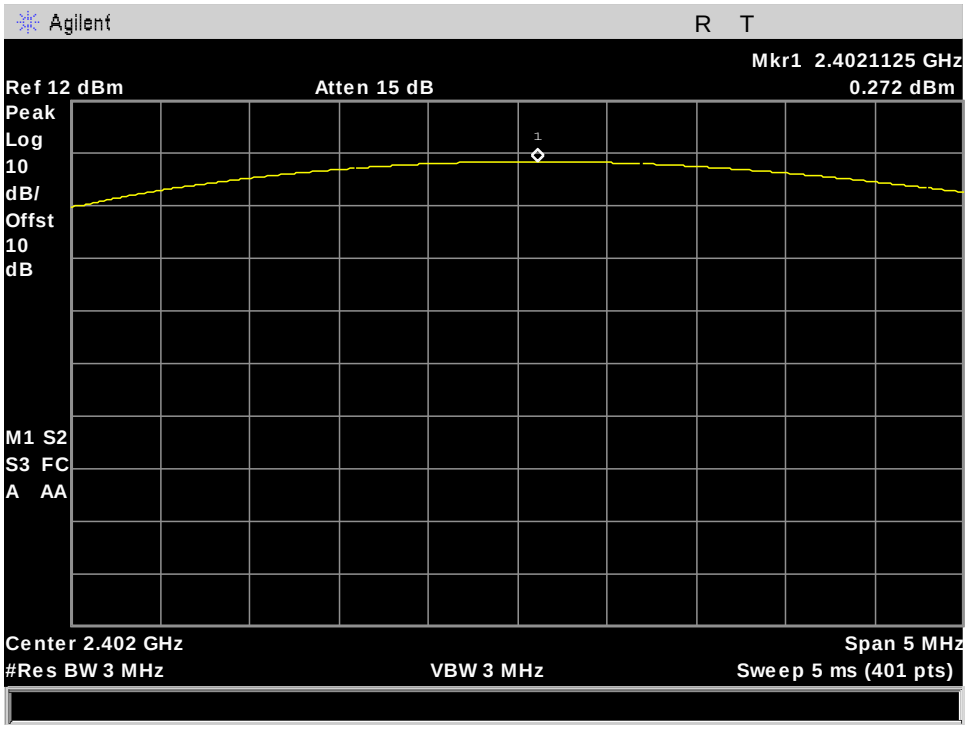

Figure 54: Peak Power Output, DH1_2402

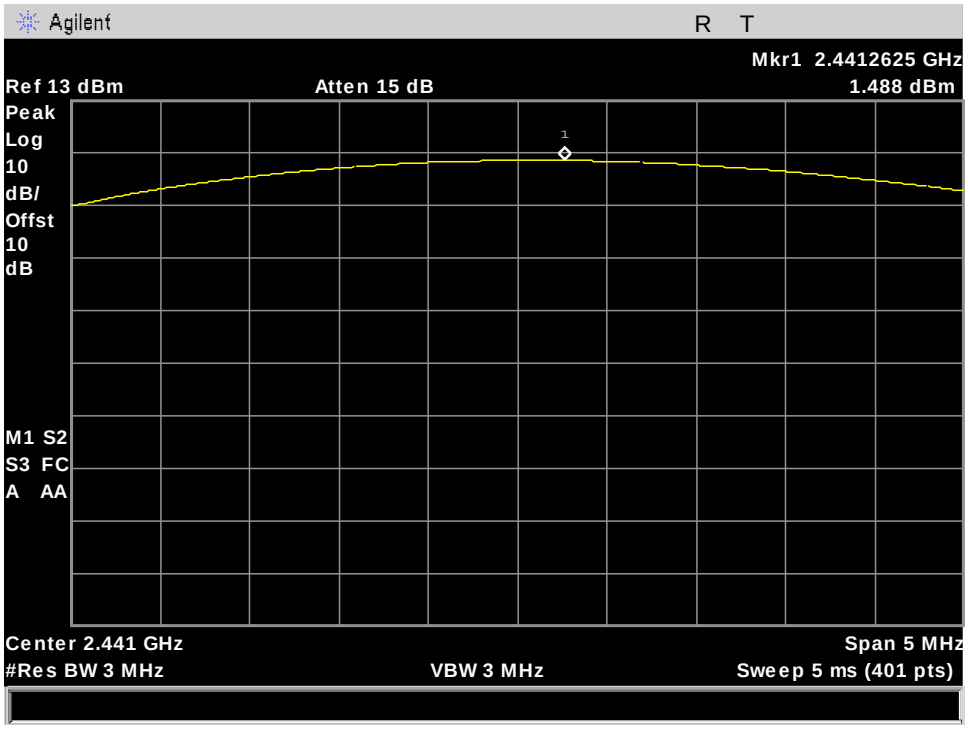

Figure 55: Peak Power Output, DH1_2441

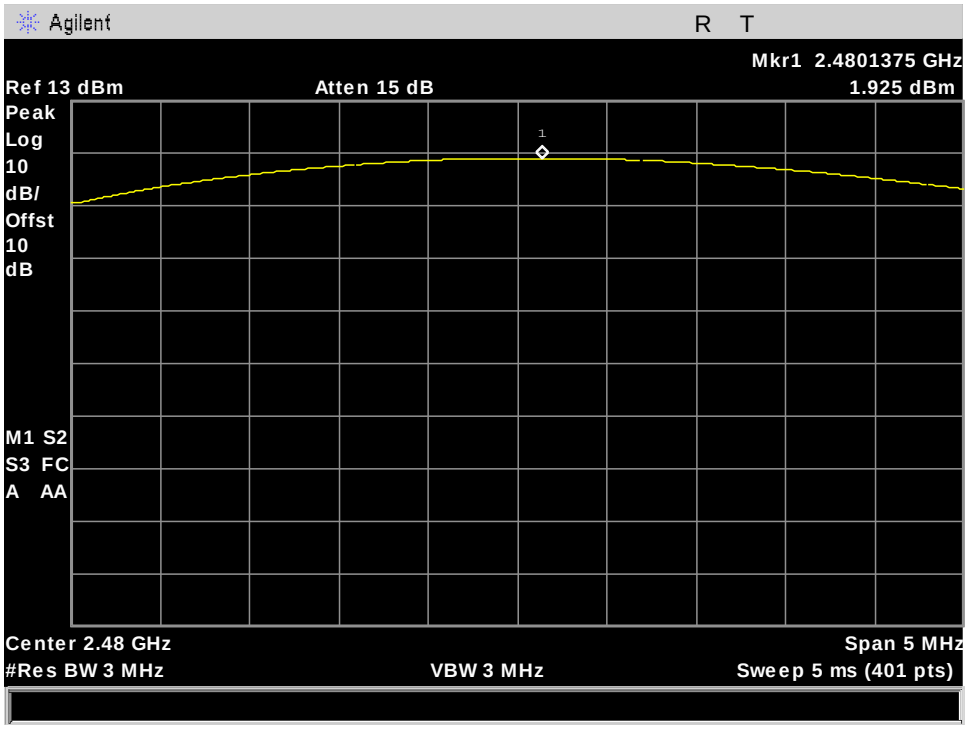

Figure 56: Peak Power Output, DH1_2480

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

Test Requirements: **§15.247(d); §15.205:** Emissions outside the frequency band.

§15.247(d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

§15.205(a): Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090–0.110----------	16.42–16.423	399.9–410	4.5–5.15
[1] 0.495–0.505----------	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905----------	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128----------	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775----------	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775----------	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218----------	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825----------	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225----------	123–138	2200–2300	14.47–14.5
8.291–8.294----------	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366----------	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675----------	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475----------	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293----------	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025----------	240–285	3345.8–3358 36.	43–36.5
12.57675–12.57725----------	322–335.4	3600–4400	([2])

Figure 57: Restricted Bands of Operation

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

Test Requirement(s): **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Figure 58:

Frequency (MHz)	§ 15.209(a),Radiated Emission Limits (dBµV) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54.00

Figure 58: Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

Test Procedure: The transmitter was set to transmit continuously at the highest output power and placed on a 0.8 m high wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurement were done at the low, mid and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor

Test Results: The EUT was **compliant** to the requirement(s) of this section. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: March 25, 2020

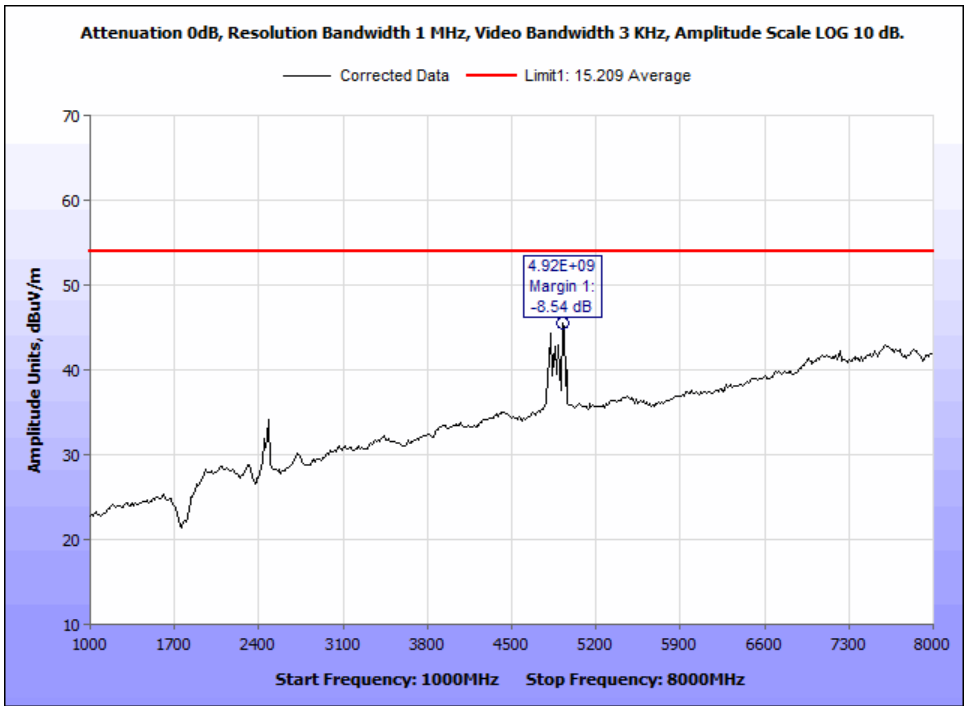

Figure 59: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated emissions_2-DH1_1-8 GHz.

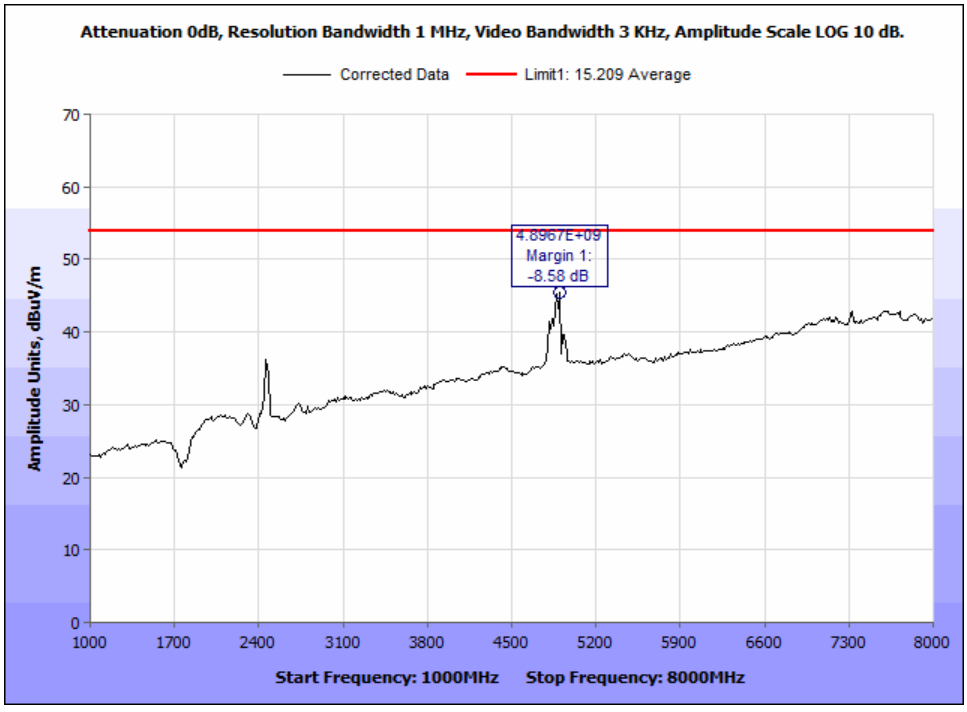

Figure 60: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated emissions_3-DH1_1-8 GHz.

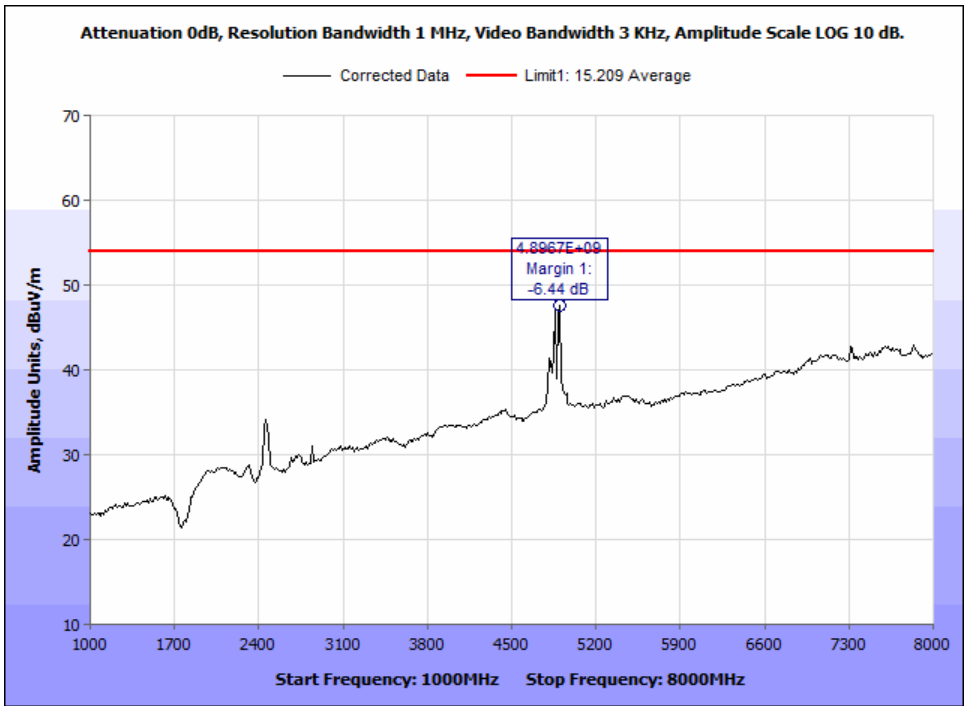

Figure 61: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated emissions_DH1_1-8 GHz.

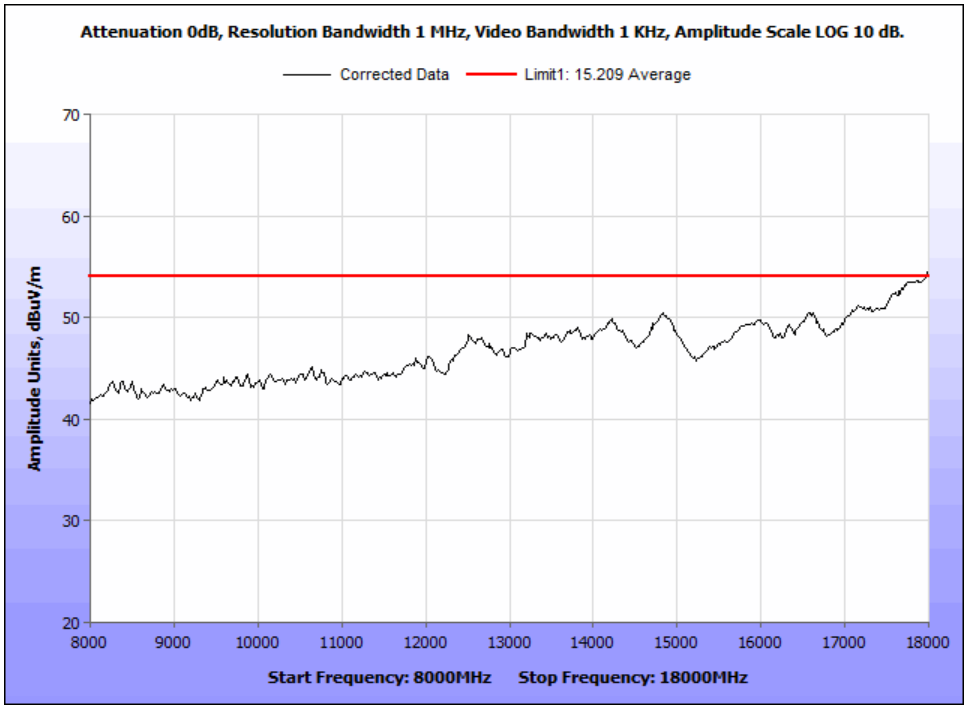

Figure 62: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated emissions_worst case_8-18 GHz.

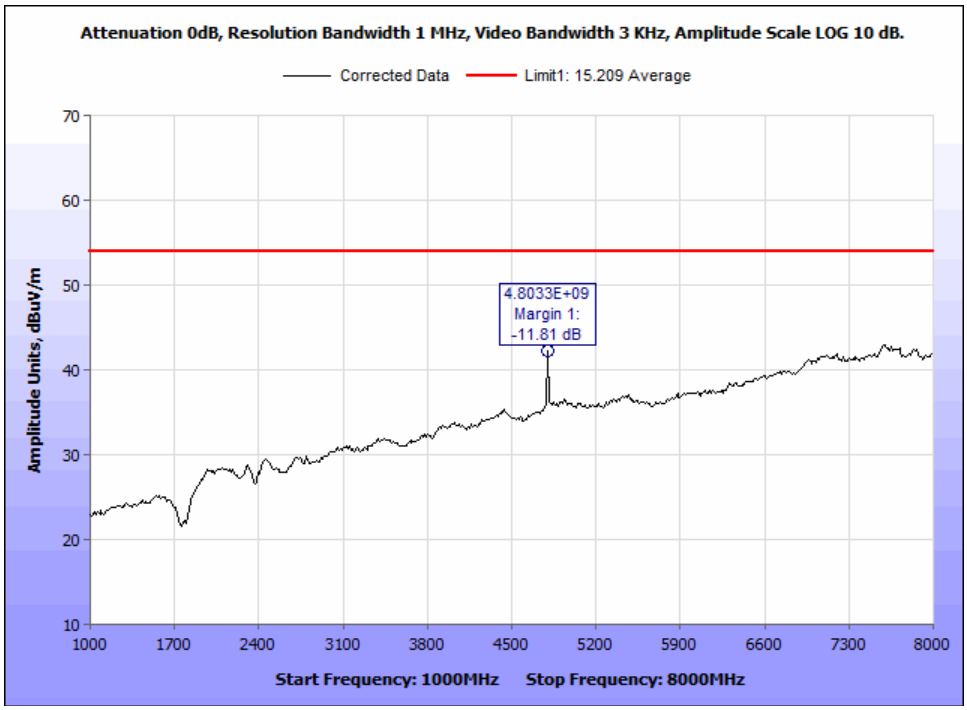

Figure 63: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_2-DH1_2402M_1-8 GHz.

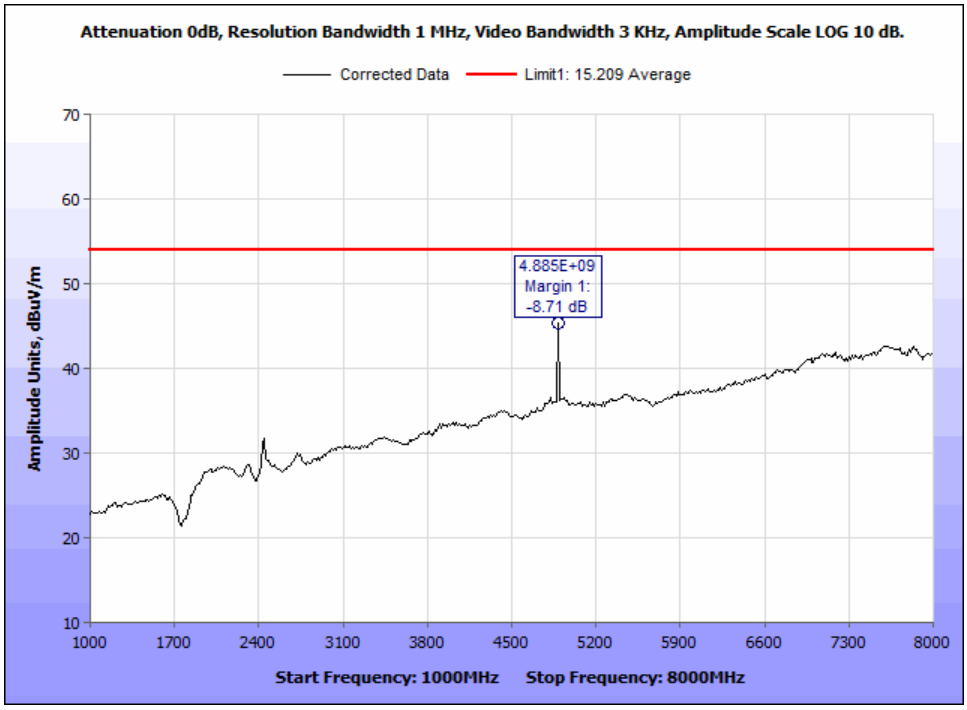

Figure 64: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_2-DH1_2441M_1-8 GHz.

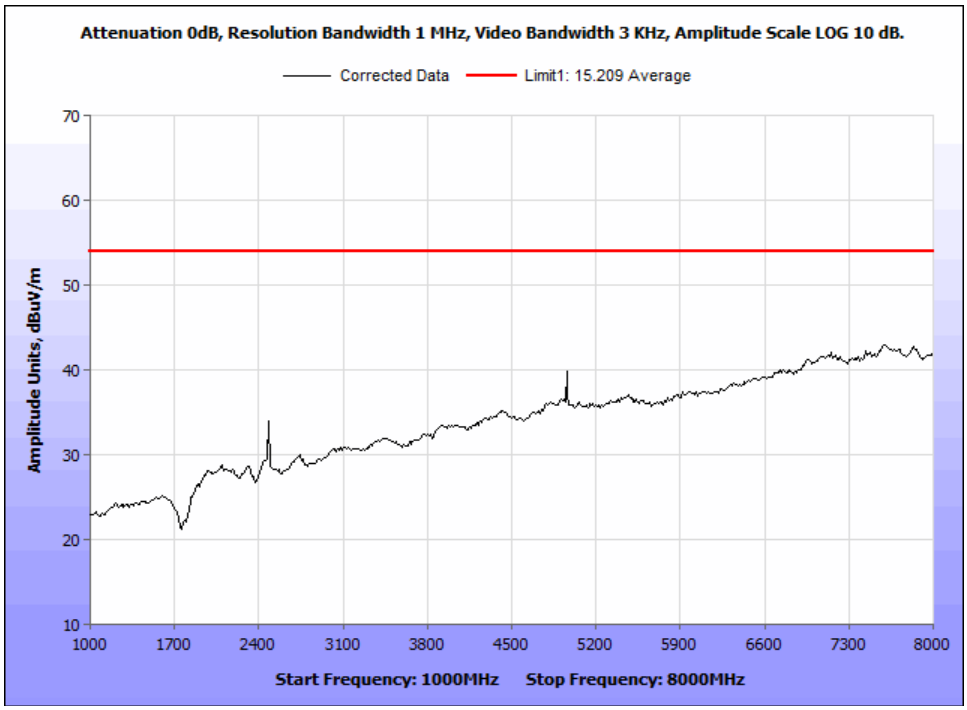

Figure 65: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_2-DH1_2480M_1-8 GHz.

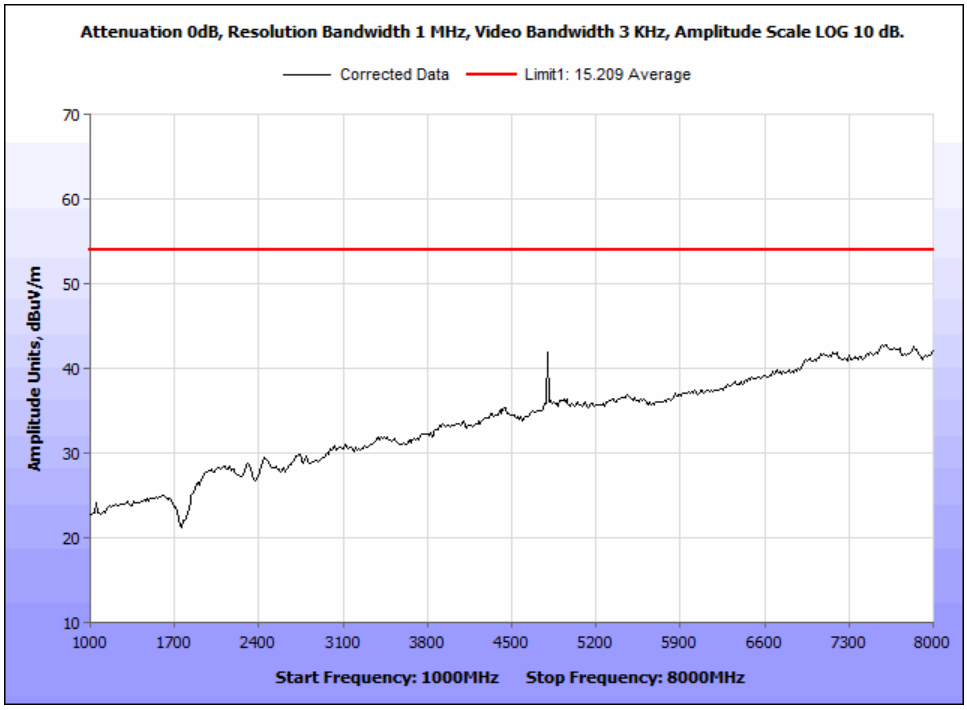

Figure 66: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_3-DH1_2402M_1-8 GHz.

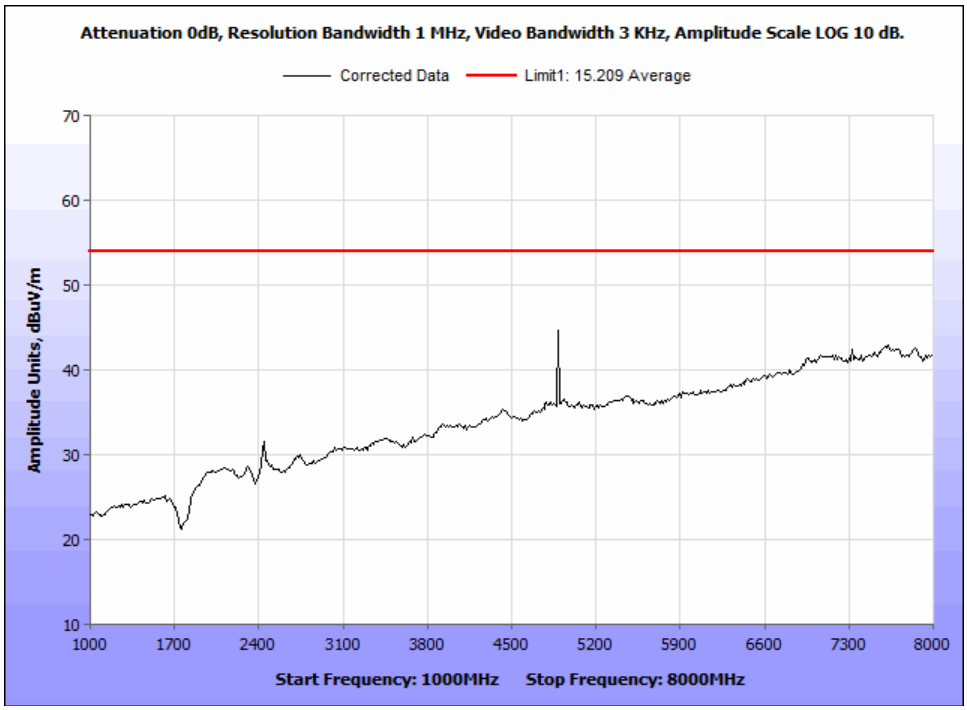

Figure 67: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_3-DH1_2441M_1-8 GHz.

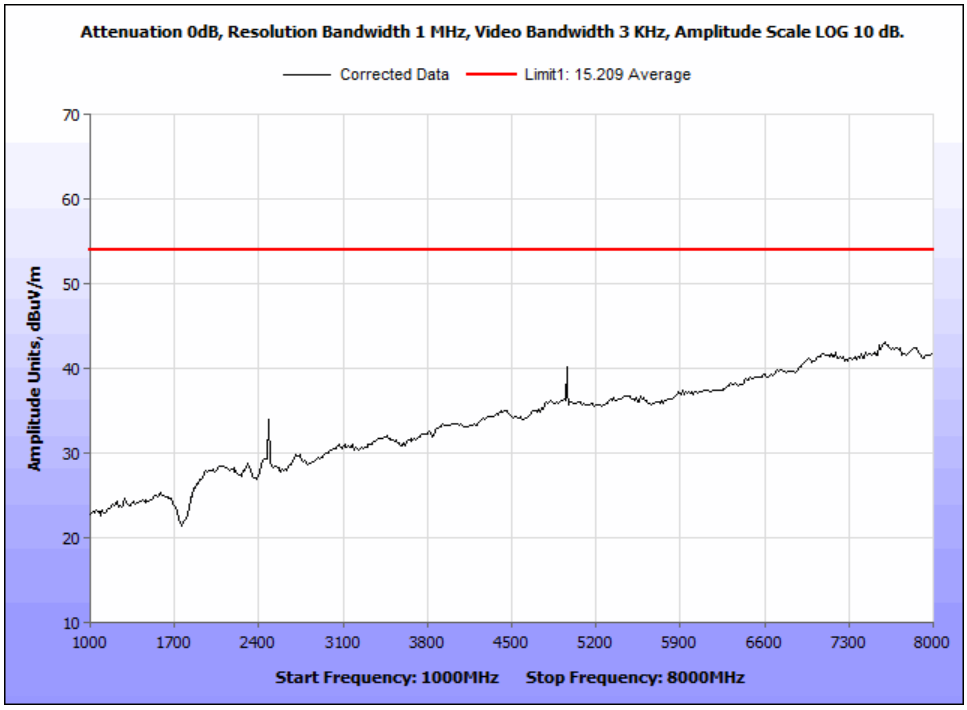

Figure 68: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_3-DH1_2480M_1-8 GHz.

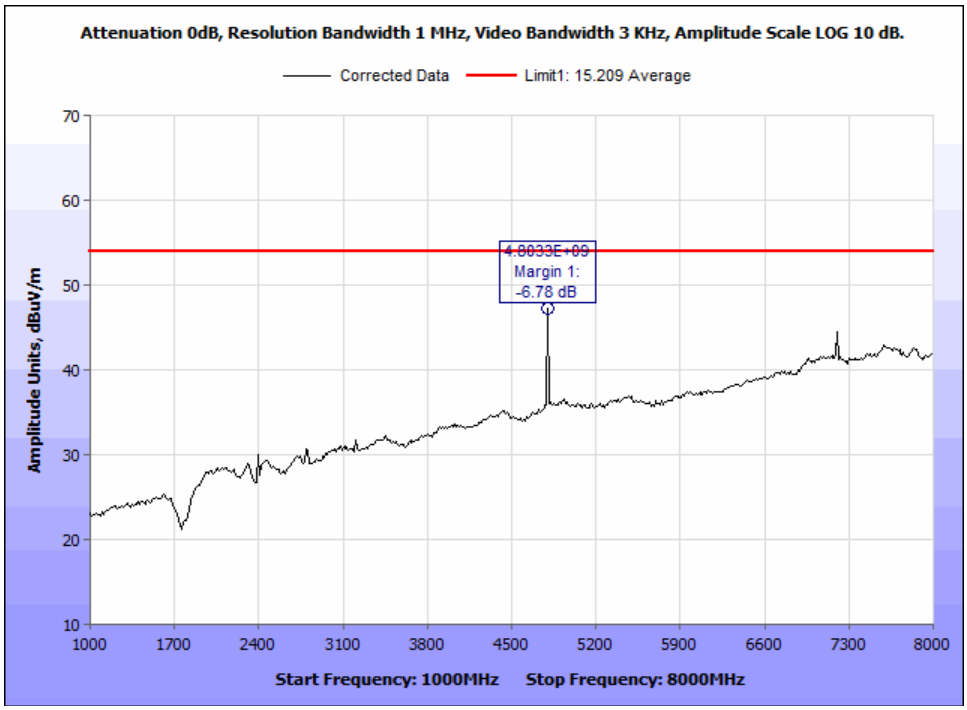

Figure 69: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_DH1_2402M_1-8 GHz.

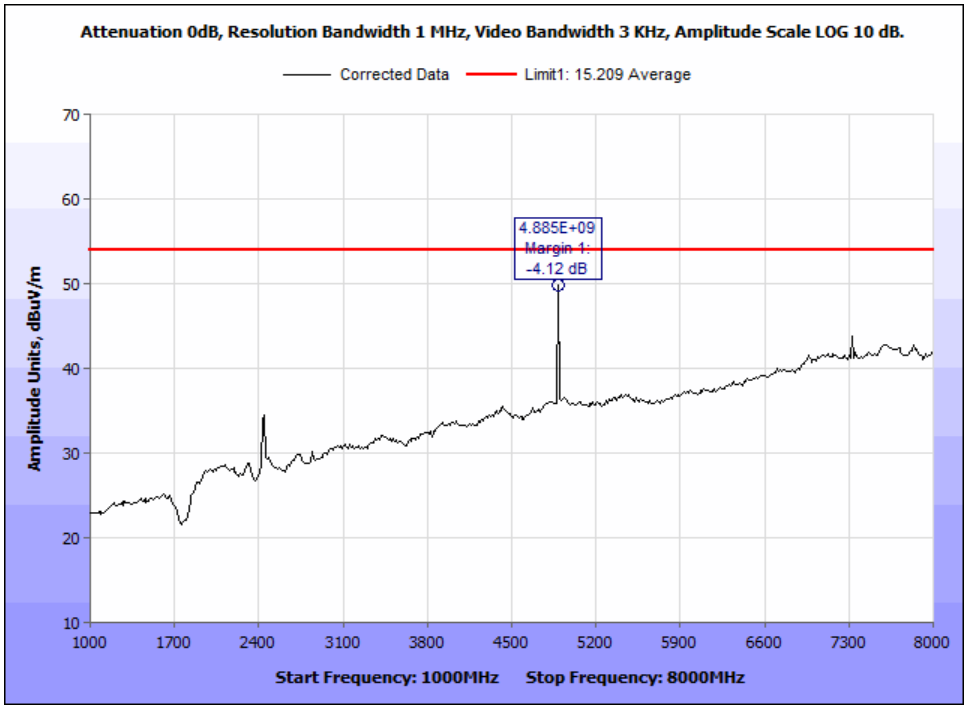

Figure 70: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_DH1_2441M_1-8 GHz.

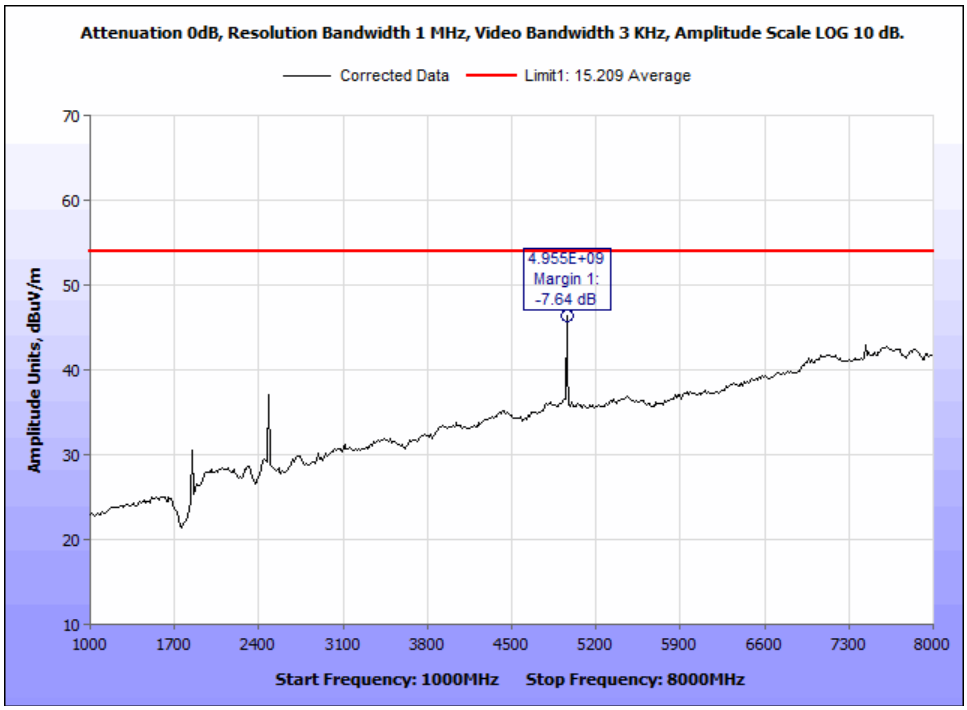

Figure 71: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_DH1_2480M_1-8 GHz.

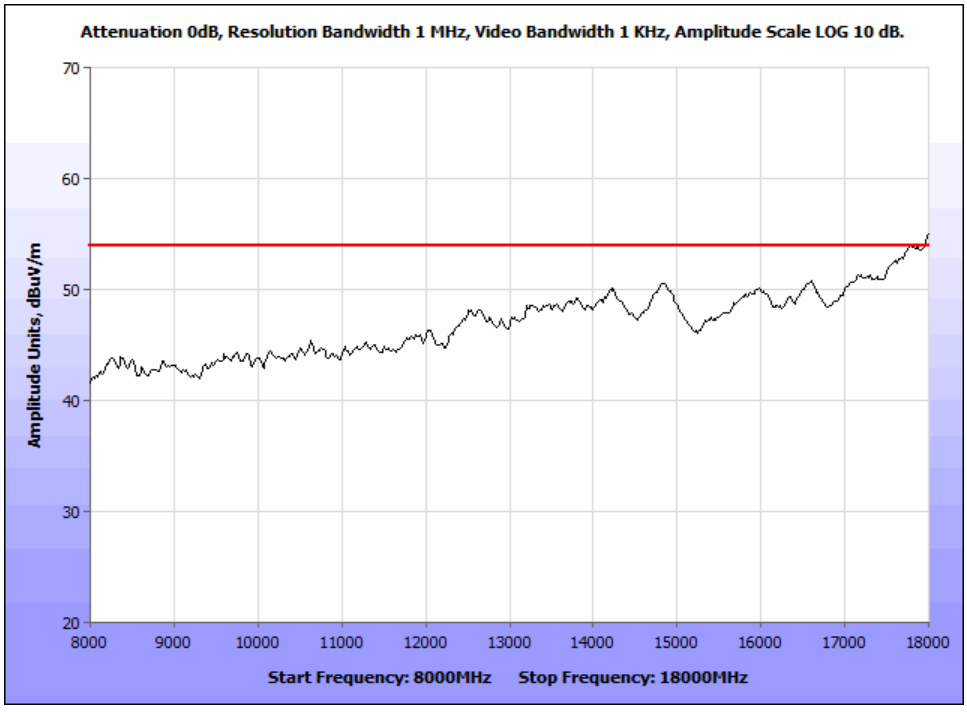

Figure 72: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated emissions_worst case_8-18 GHz.

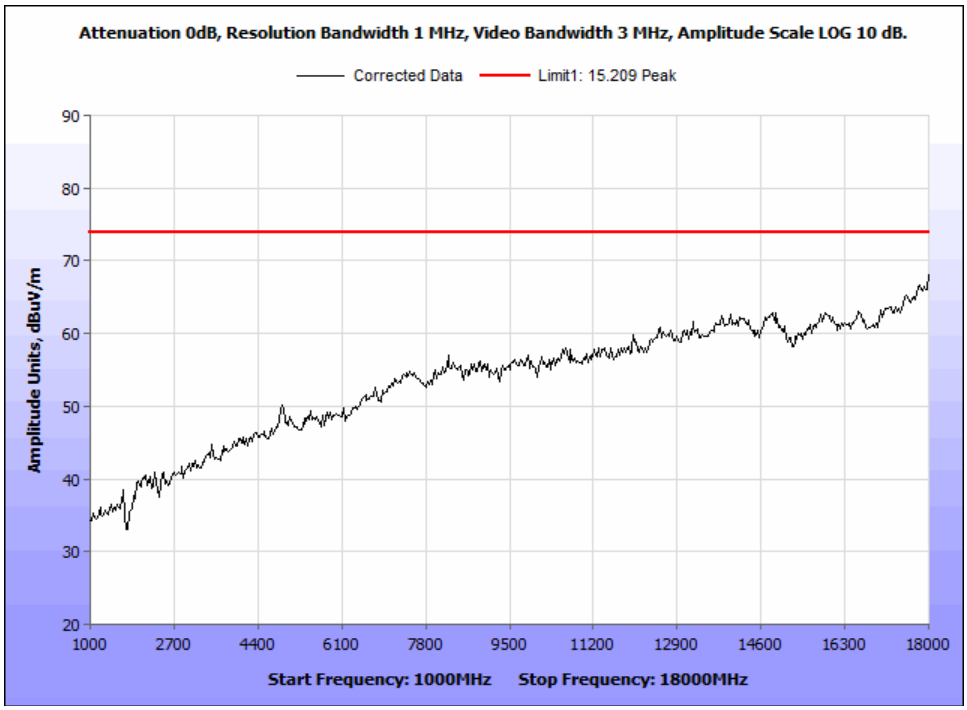

Figure 73: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated emissions_2-DH1_1-18 GHz.

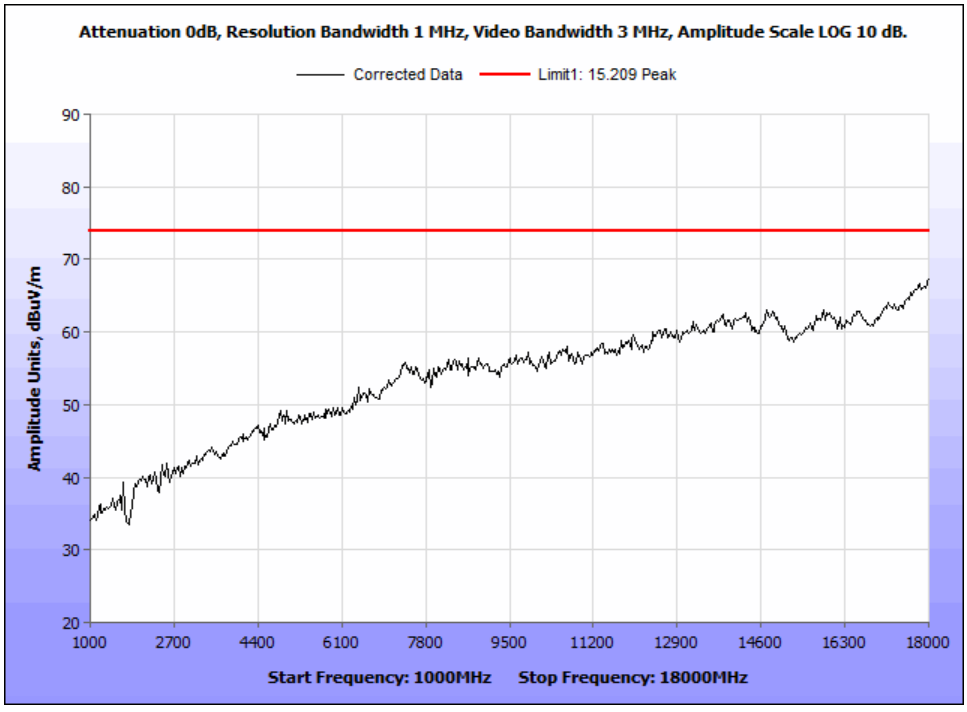

Figure 74: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated emissions_3-DH1_1-18 GHz.

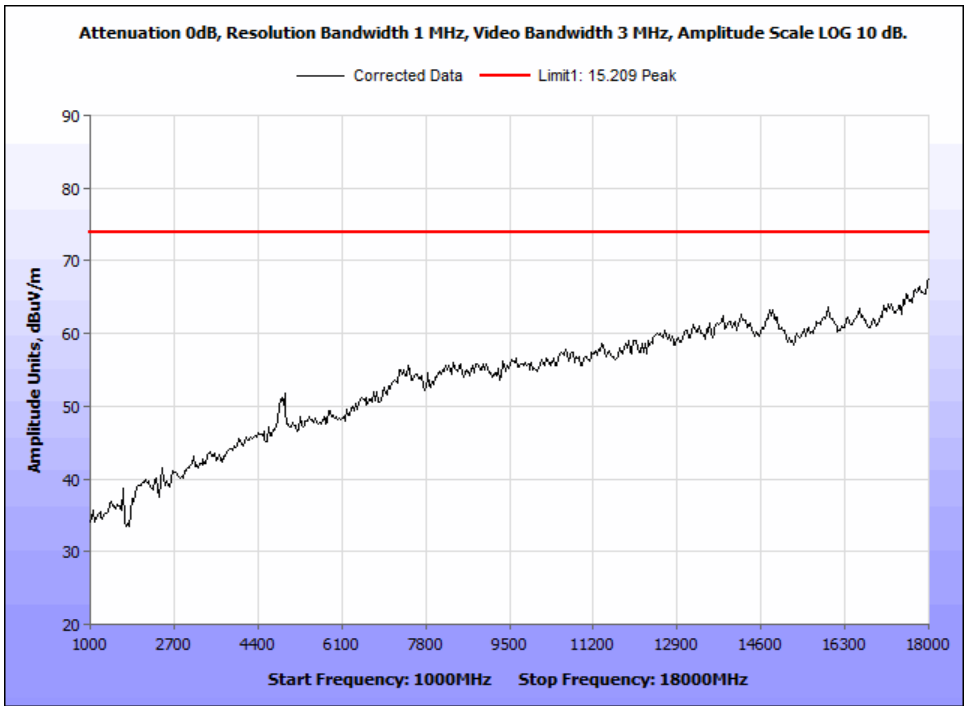

Figure 75: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated emissions_DH1_1-18 GHz.

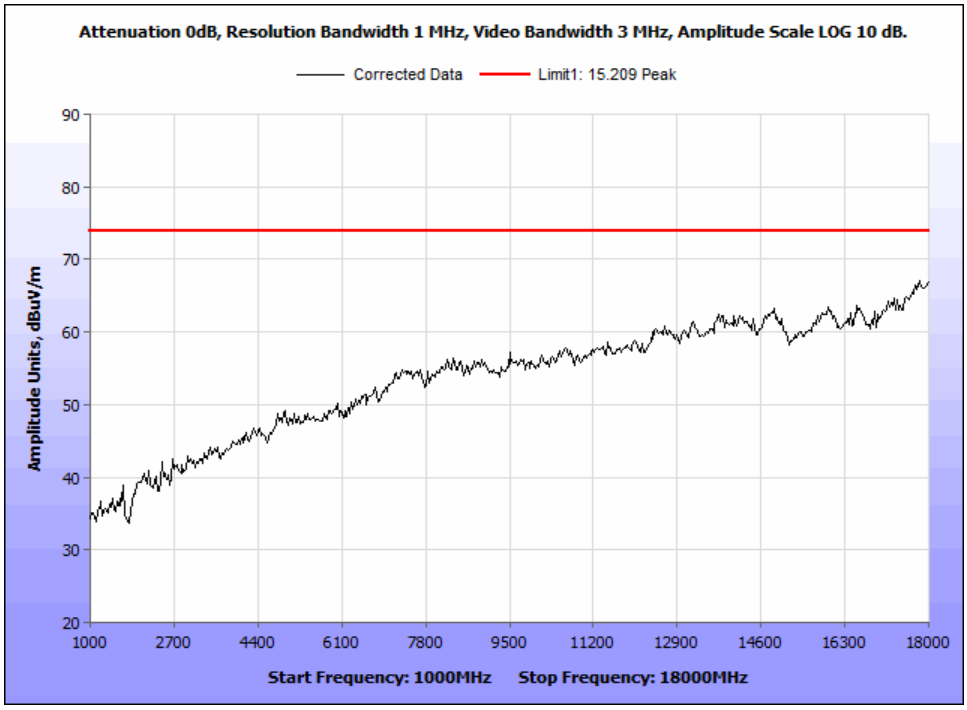

Figure 76: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_2-DH1_2402M_1-18 GHz.

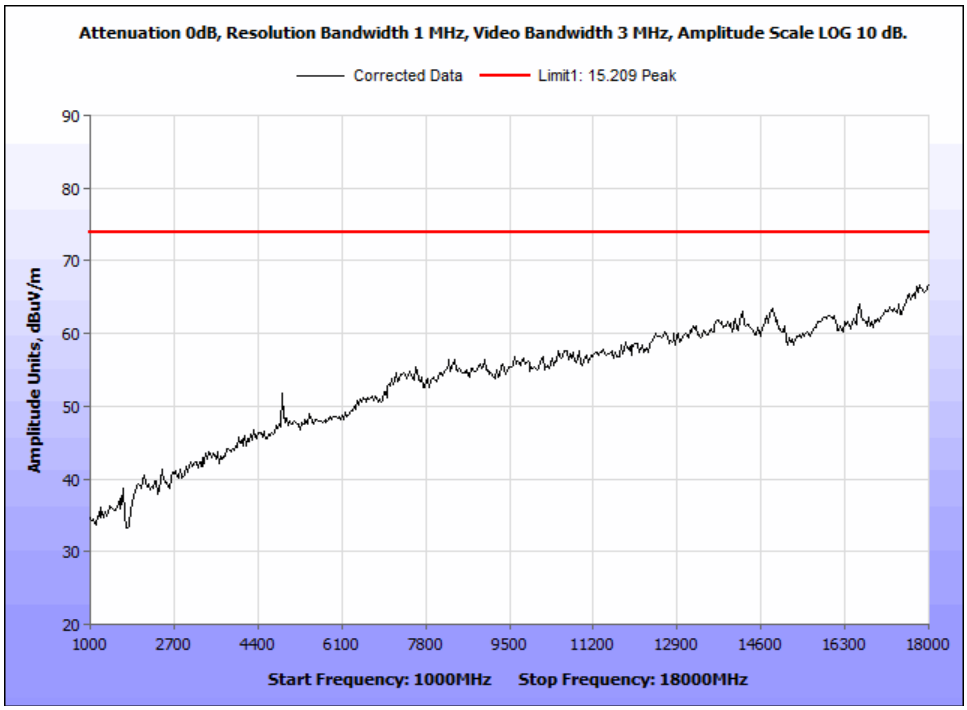

Figure 77: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_2-DH1_2441M_1-18 GHz.

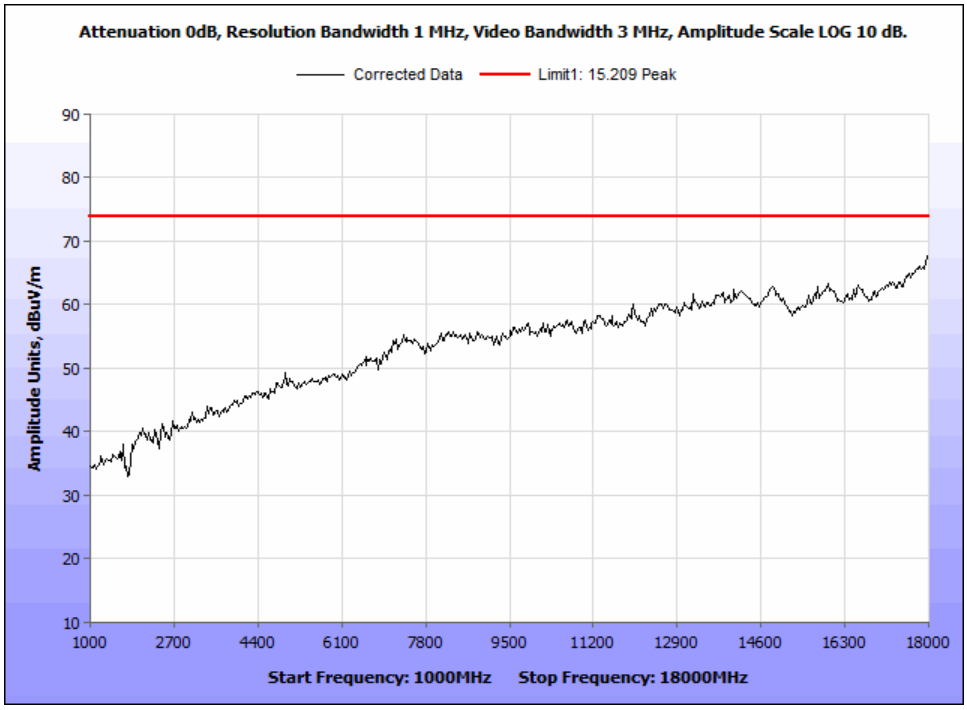

Figure 78: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_2-DH1_2480M_1-18 GHz.

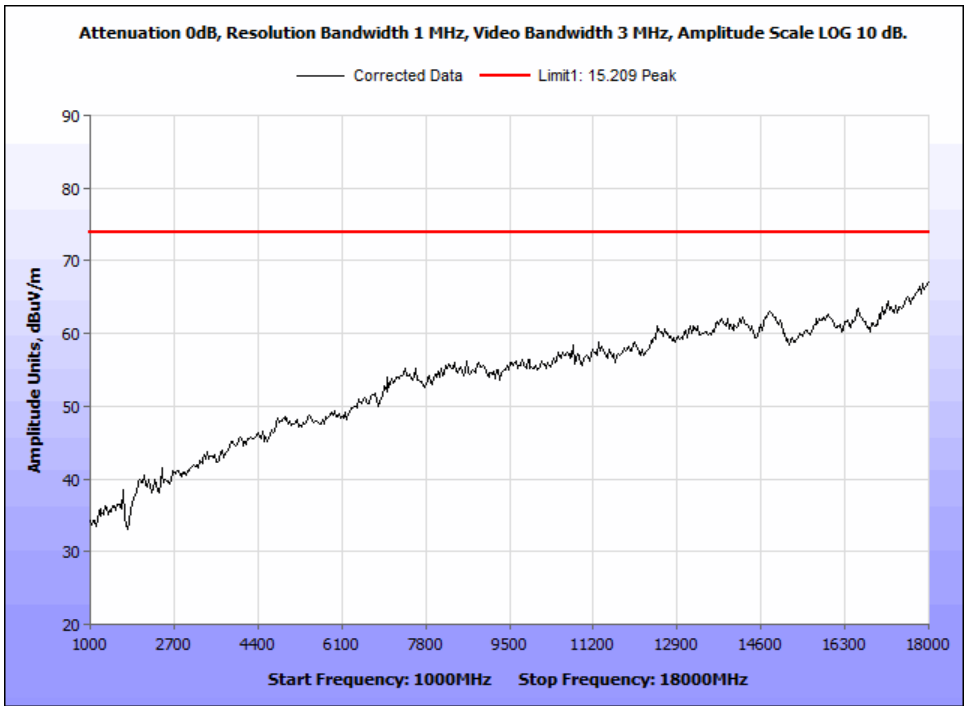

Figure 79: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_3-DH1_2402M_1-18 GHz.

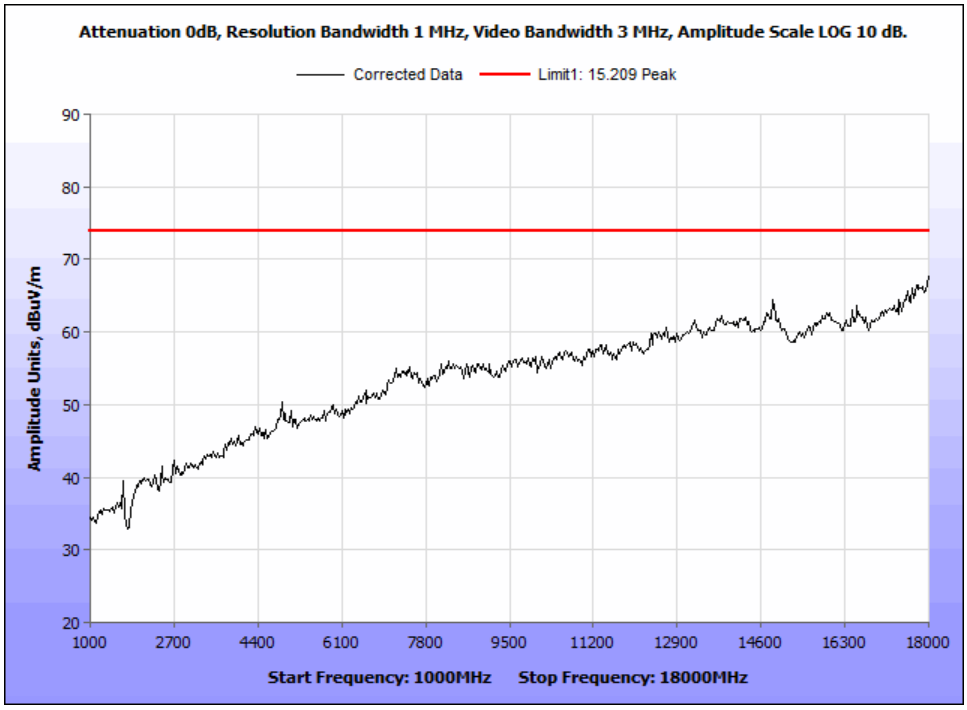

Figure 80: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_3-DH1_2441M_1-18 GHz.

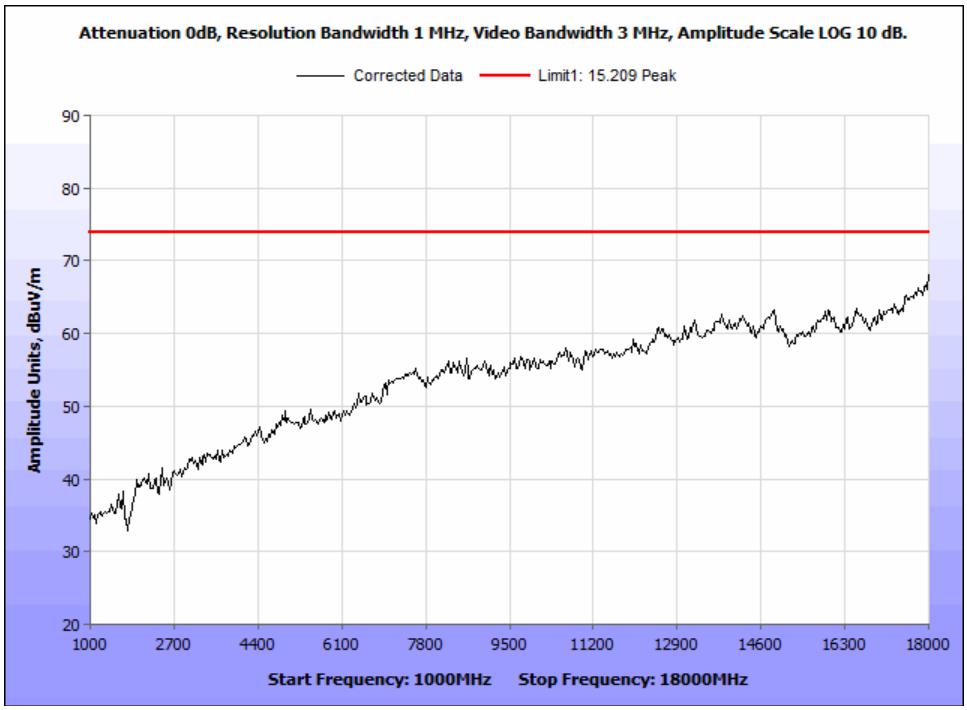

Figure 81: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_3-DH1_2480M_1-18 GHz.

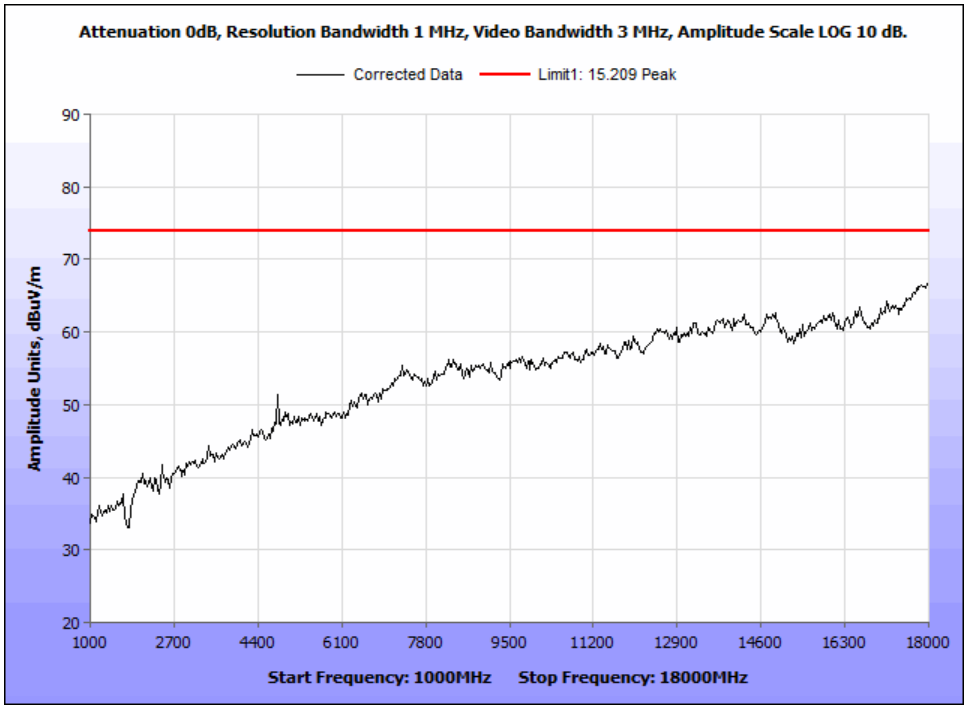

Figure 82: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_DH1_2402M_1-18 GHz.

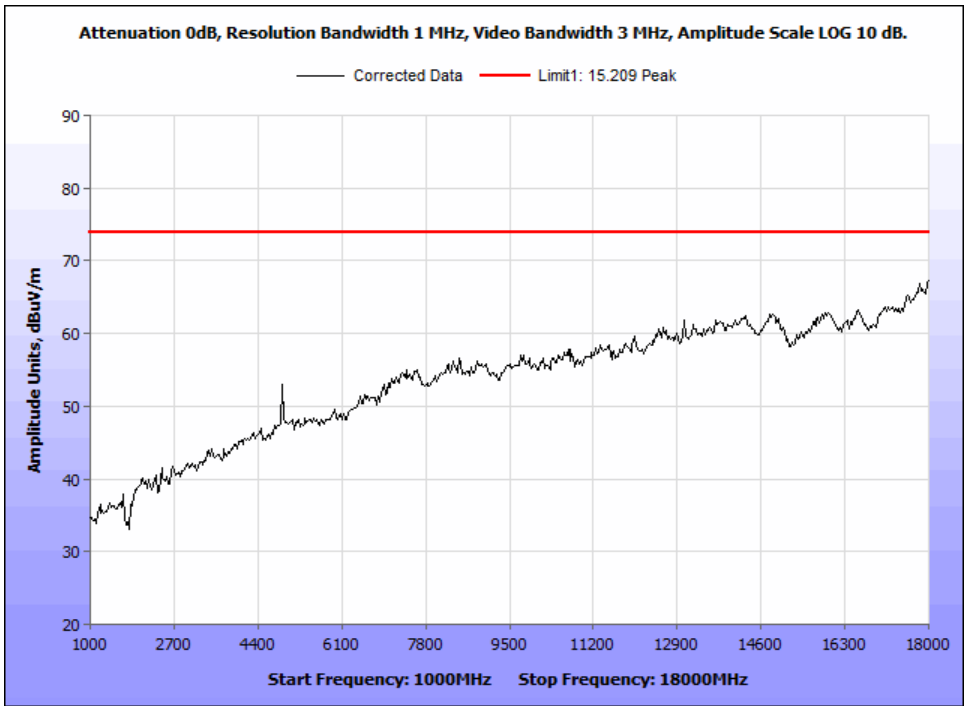

Figure 83: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_DH1_2441M_1-18 GHz.

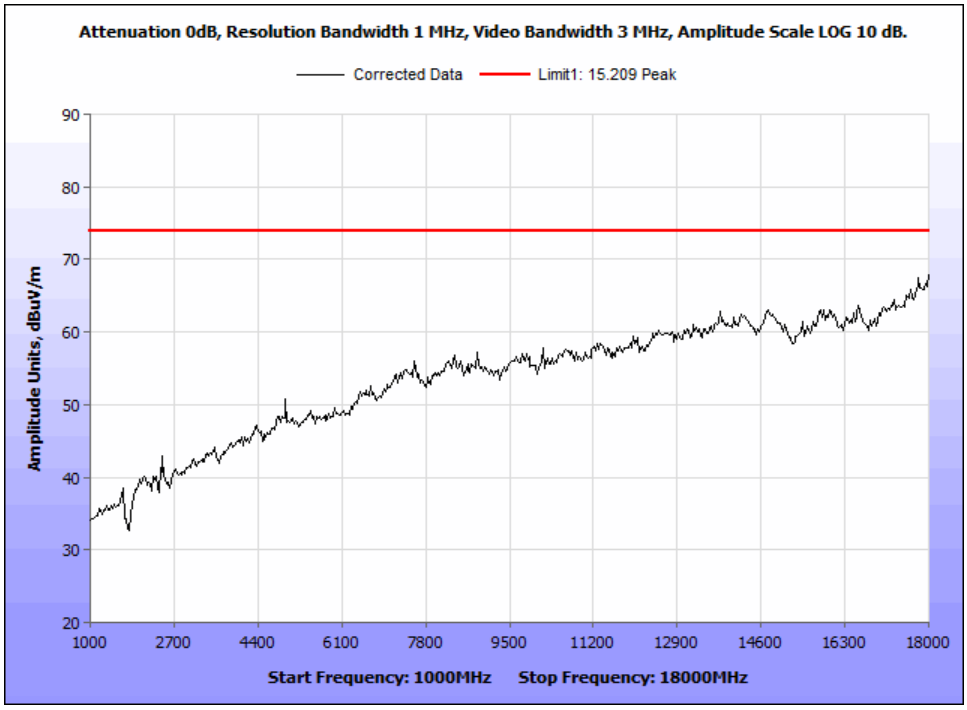

Figure 84: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated emissions_DH1_2480M_1-18 GHz.

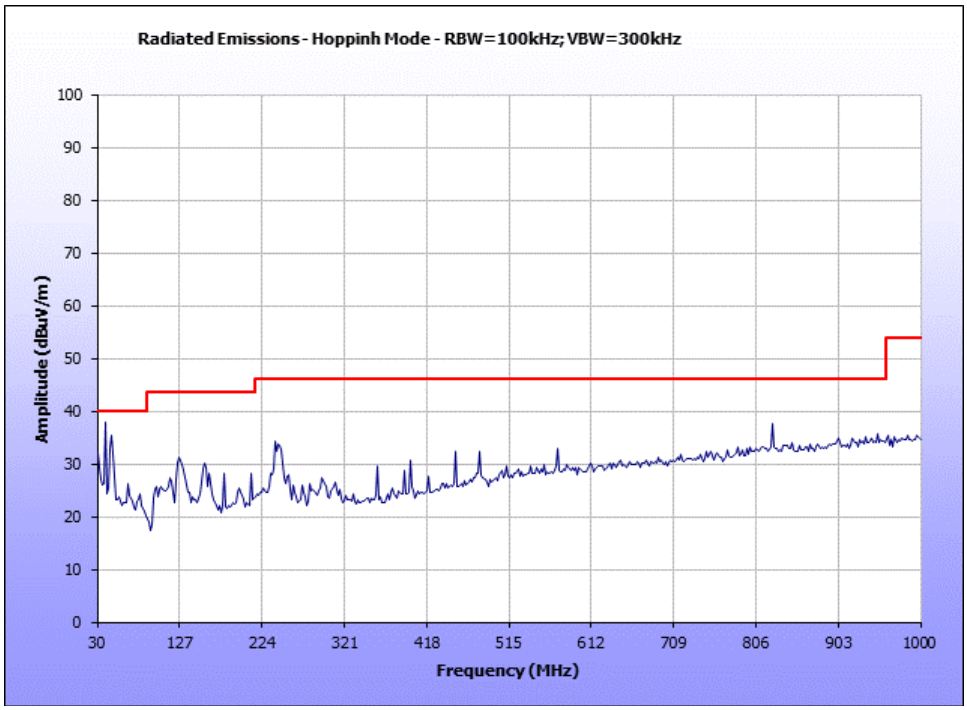

Figure 85: Radiated Spurious Emissions Requirements and Band Edge, Radiated Emissions_hopping_worst case_30-1000MHz.

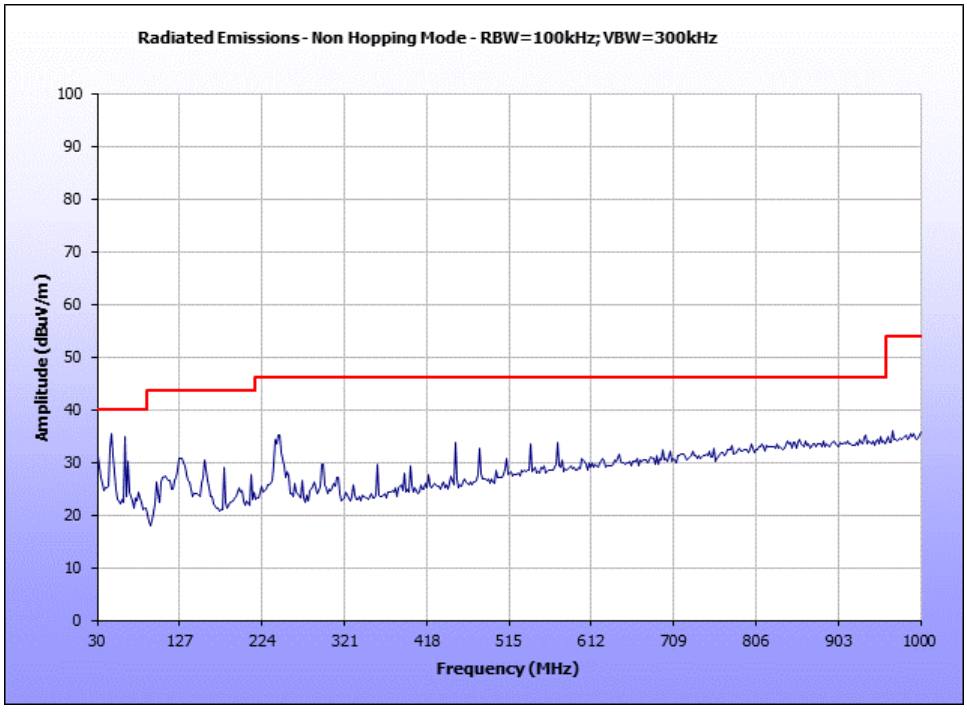

Figure 86: Radiated Spurious Emissions Requirements and Band Edge, Radiated Emissions_non-hopping_worst case_30-1000MHz.

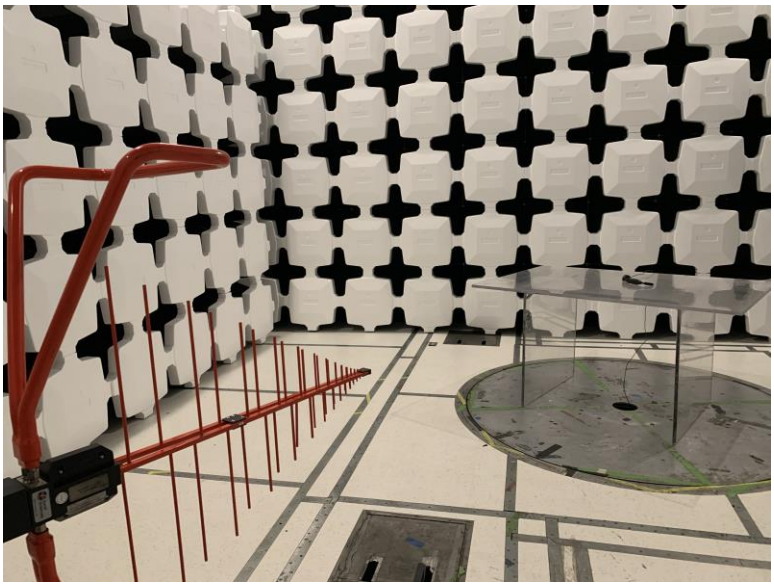

Figure 87: Radiated Spurious Emissions Requirements and Band Edge, 30 MHz - 1 GHz Radiated emission set up

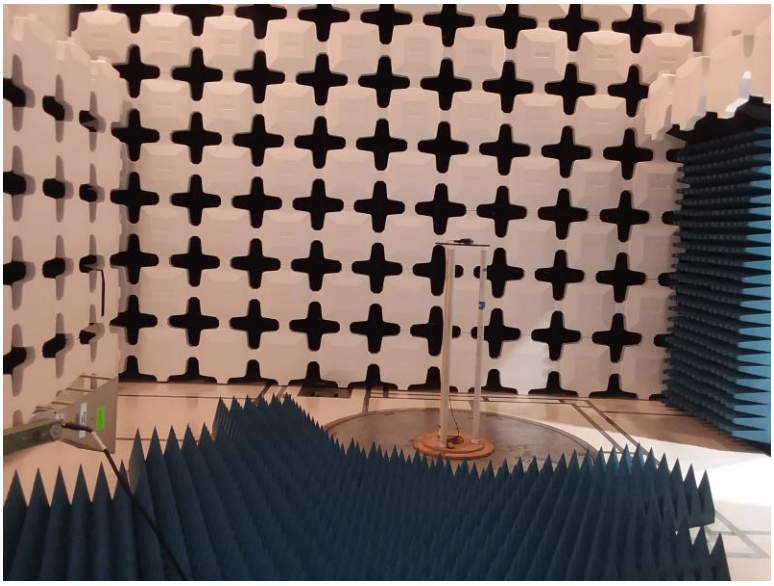

Figure 88: Radiated Spurious Emissions Requirements and Band Edge, 1 - 18 GHz Radiated emissions setup

Radiated Band Edge Measurements

Test Procedures: The transmitter was turned. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance.

Test Procedures for Radiated Band Edge for High Channel 2480 MHz:

1. The field strength of the fundamental emission was measured using a MHz RBW and a 3MHz VBW for the peak value and a 1MHz RBW and a 10Hz VBW for the average value.
2. The spectrum analyzer was spanned to encompass both the peak of the fundamental emission and the band edge emission under investigation. The RBW was set to 1% of the span and the VBW to 3x the RBW. The delta between the peak levels of the fundamental emission at the relevant band edge emission was measured and recorded.
3. The resulting delta value was used to determine compliance.

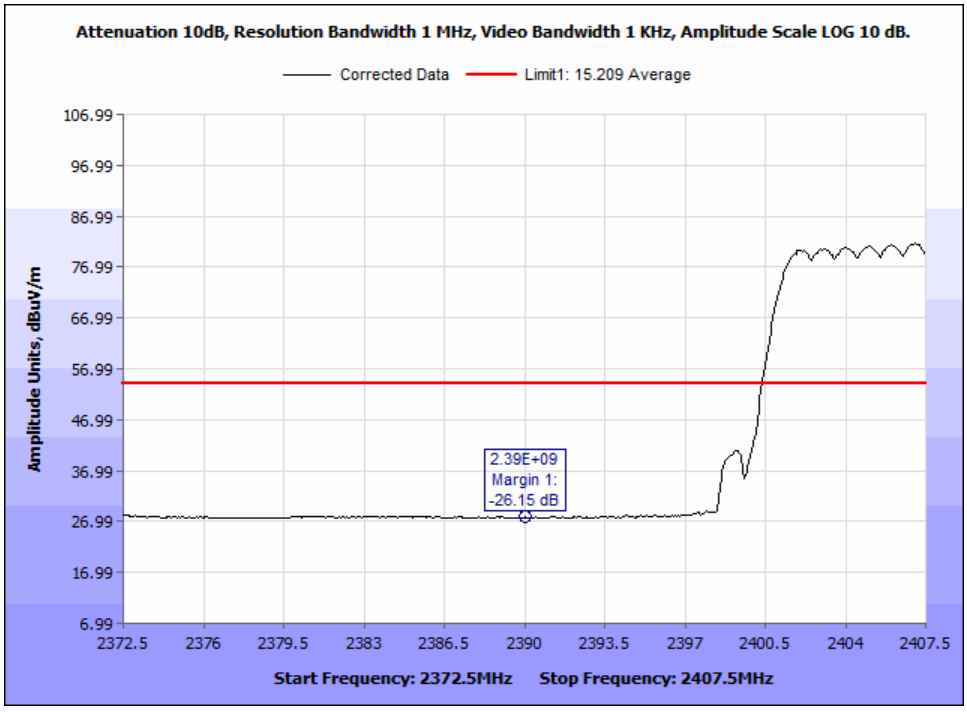

Figure 89: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2390M edge_2-DH1.

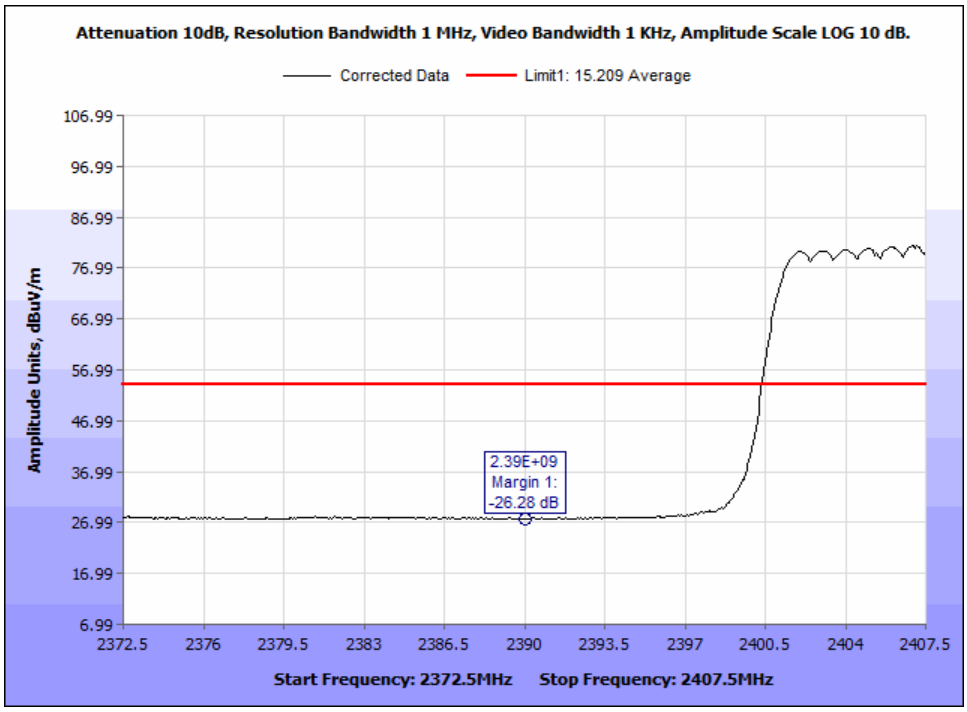

Figure 90: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2390M edge_3-DH1.

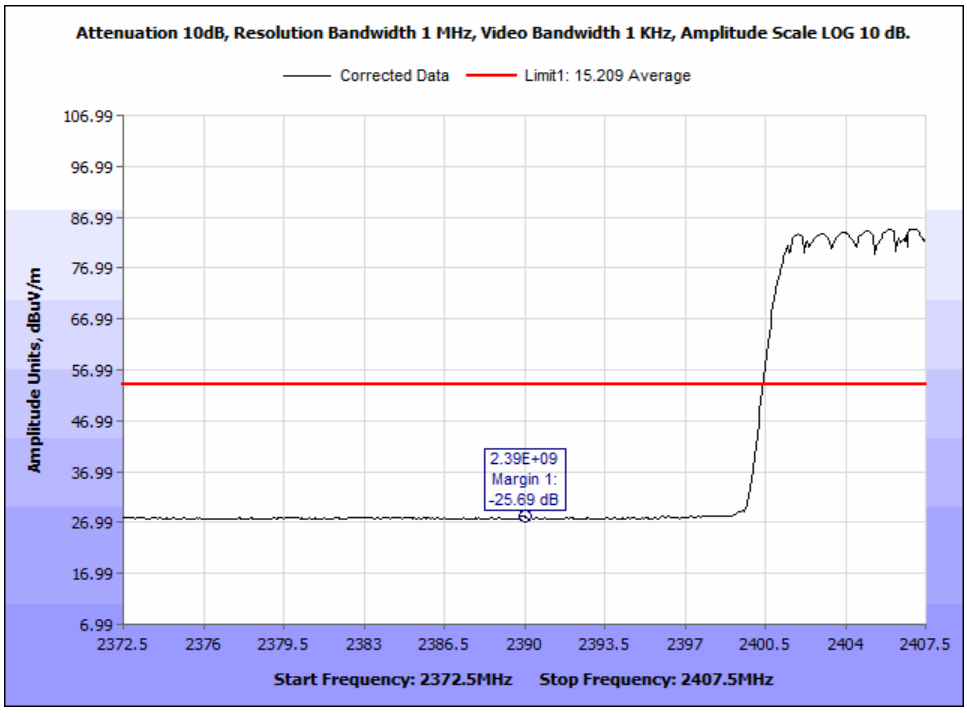

Figure 91: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2390M edge_DH1.

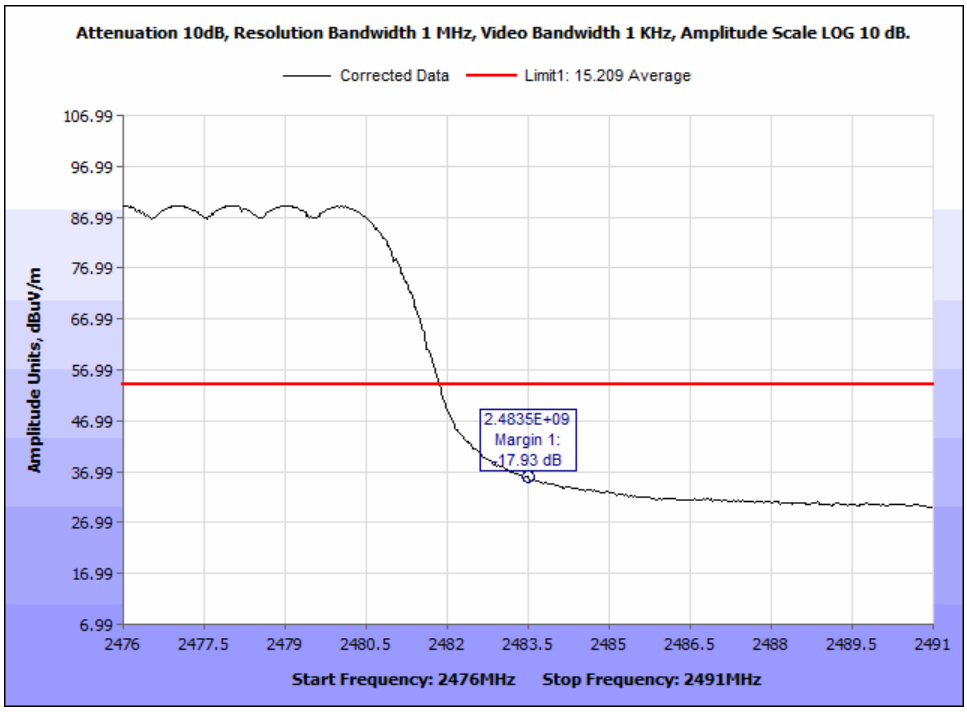

Figure 92: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2483.5M edge_2-DH1.

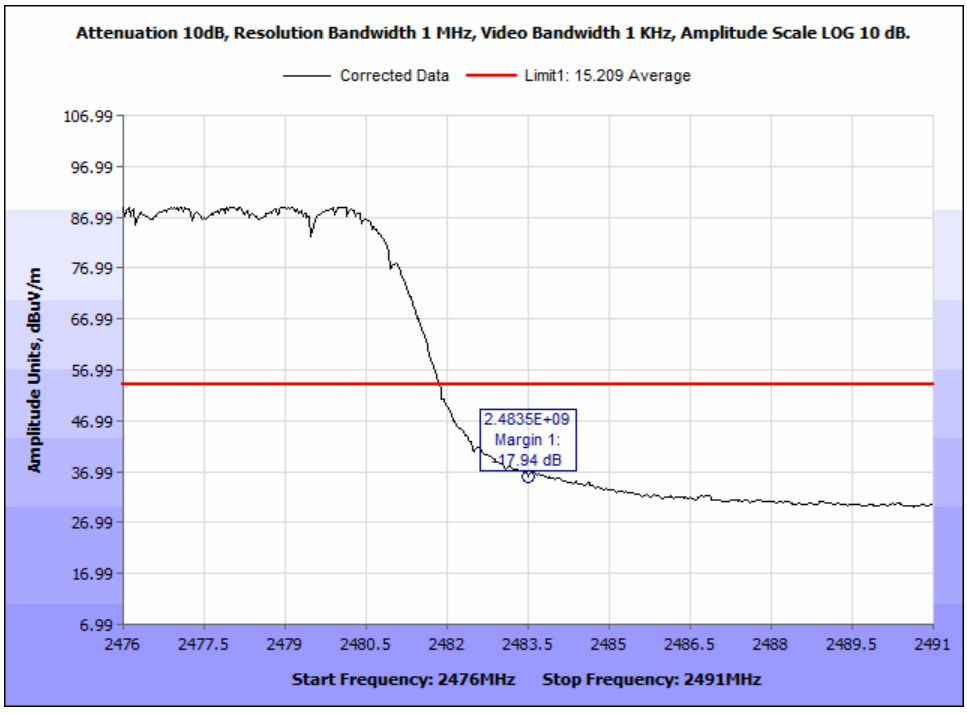

Figure 93: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2483.5M edge_3-DH1.

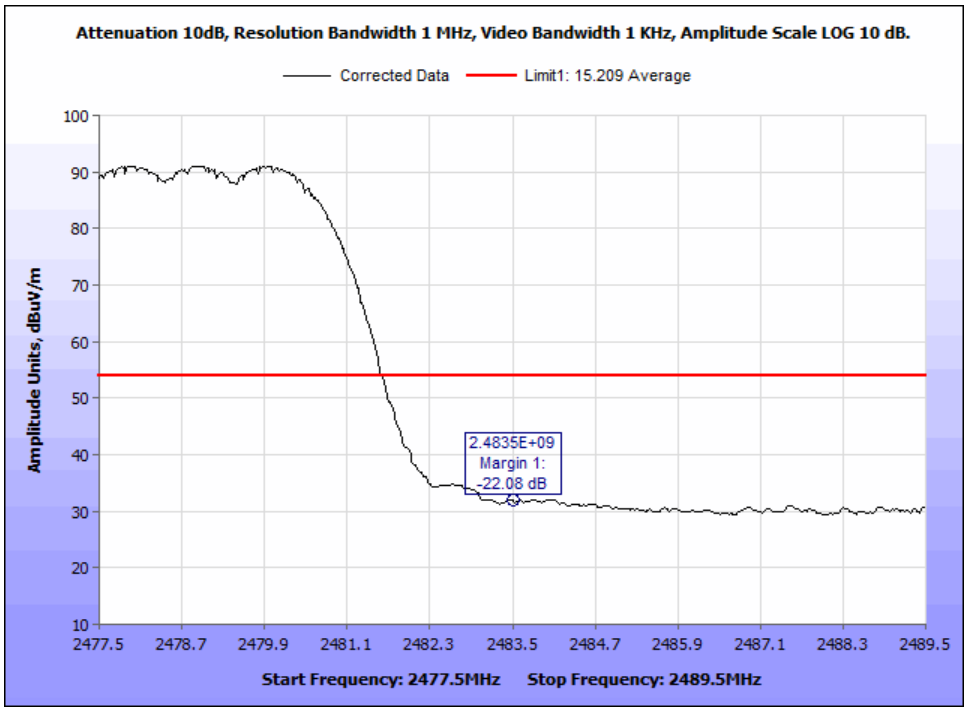

Figure 94: Radiated Spurious Emissions Requirements and Band Edge, AVG_hopping radiated bandedge_2483.5M edge_DH1.

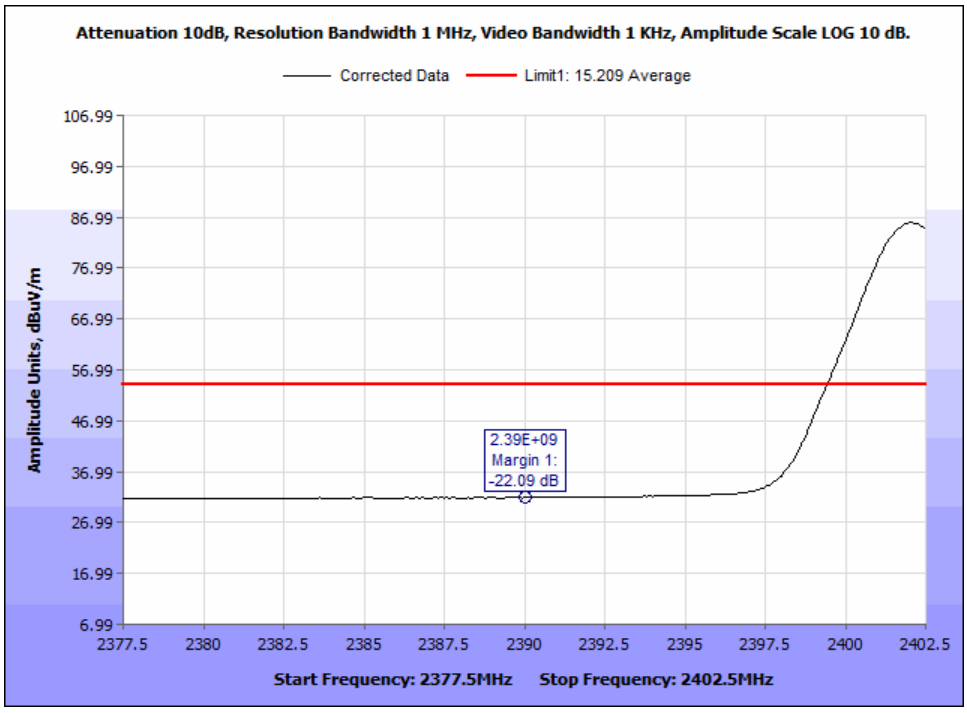

Figure 95: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2390M edge_2-DH1_2402MHz.

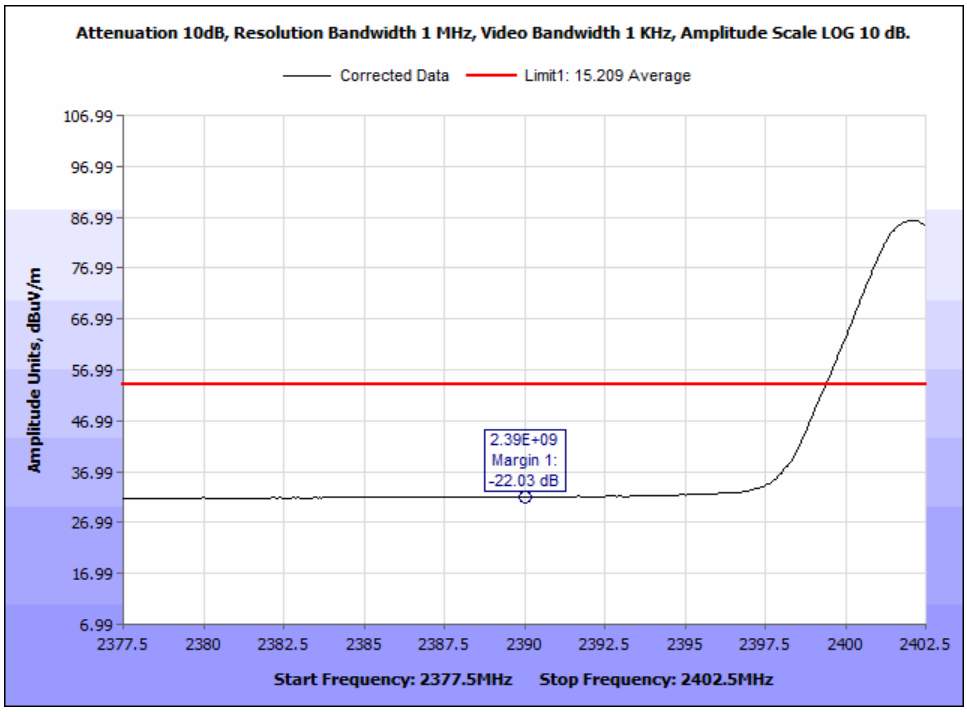

Figure 96: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2390M edge_3-DH1_2402MHz.

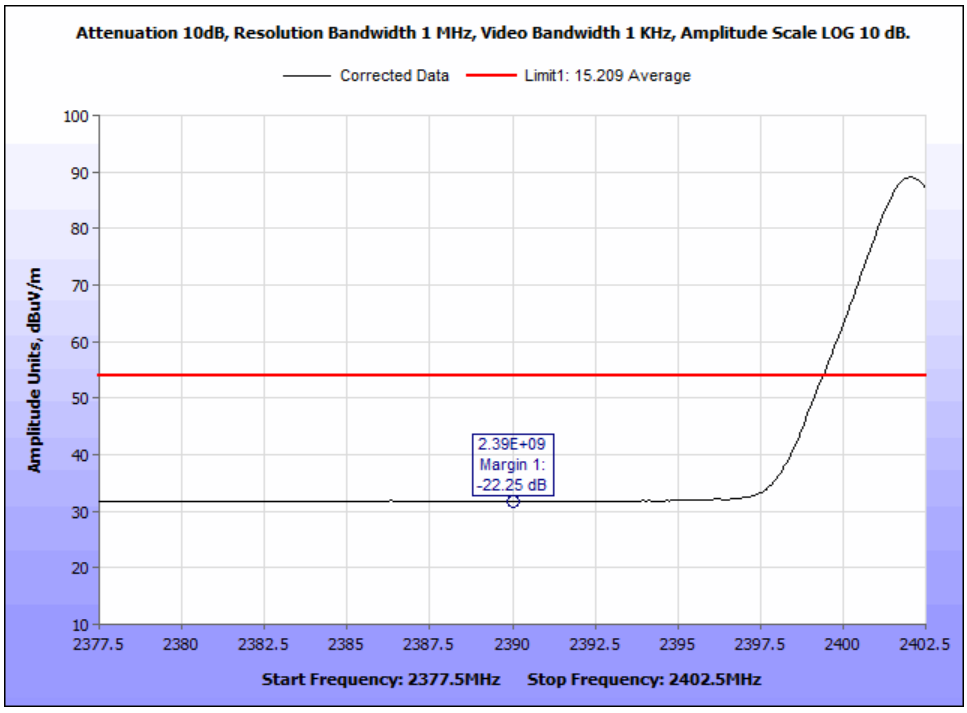

Figure 97: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2390M edge_DH1_2402MHz.

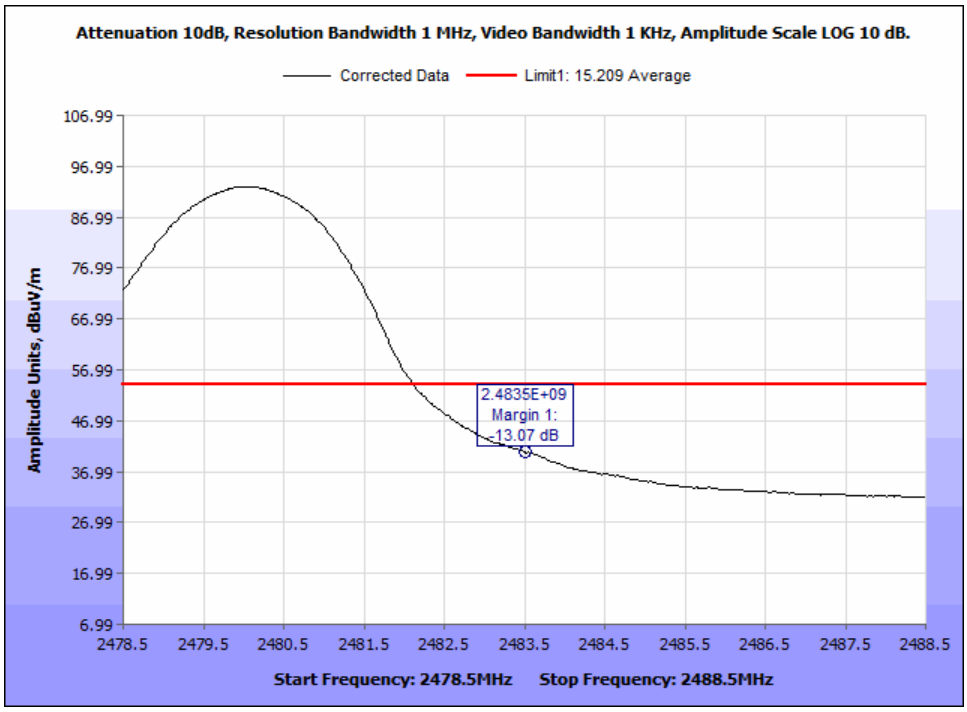

Figure 98: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2483.5M edge_2-DH1_2480MHz.

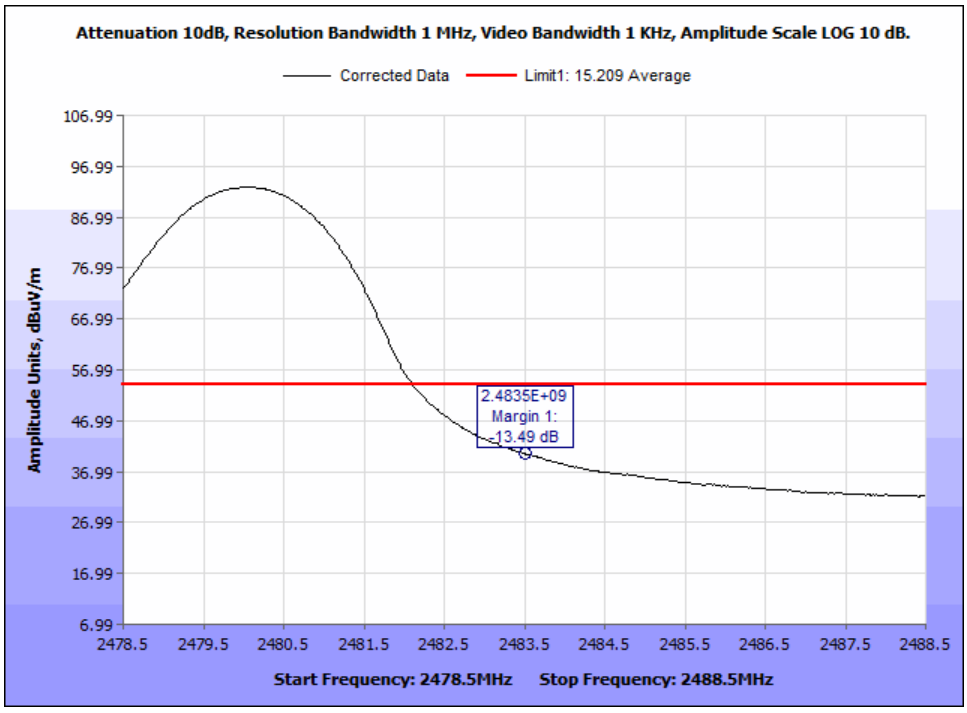

Figure 99: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2483.5M edge_3-DH1_2480MHz.

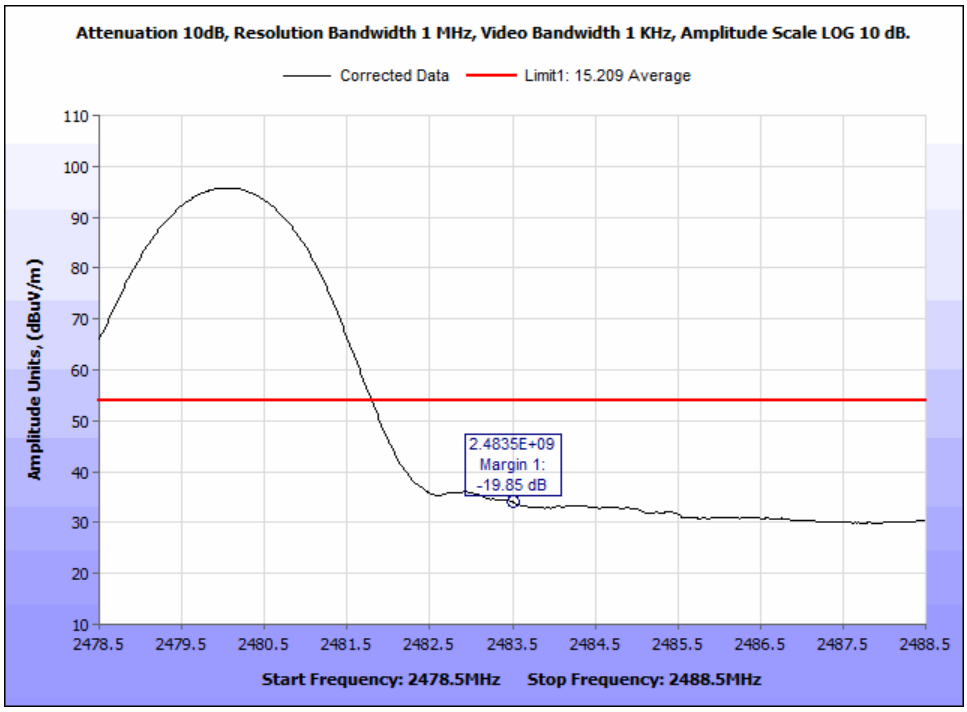

Figure 100: Radiated Spurious Emissions Requirements and Band Edge, AVG_radiated bandedge_2483.5M edge_DH1_2480MHz.

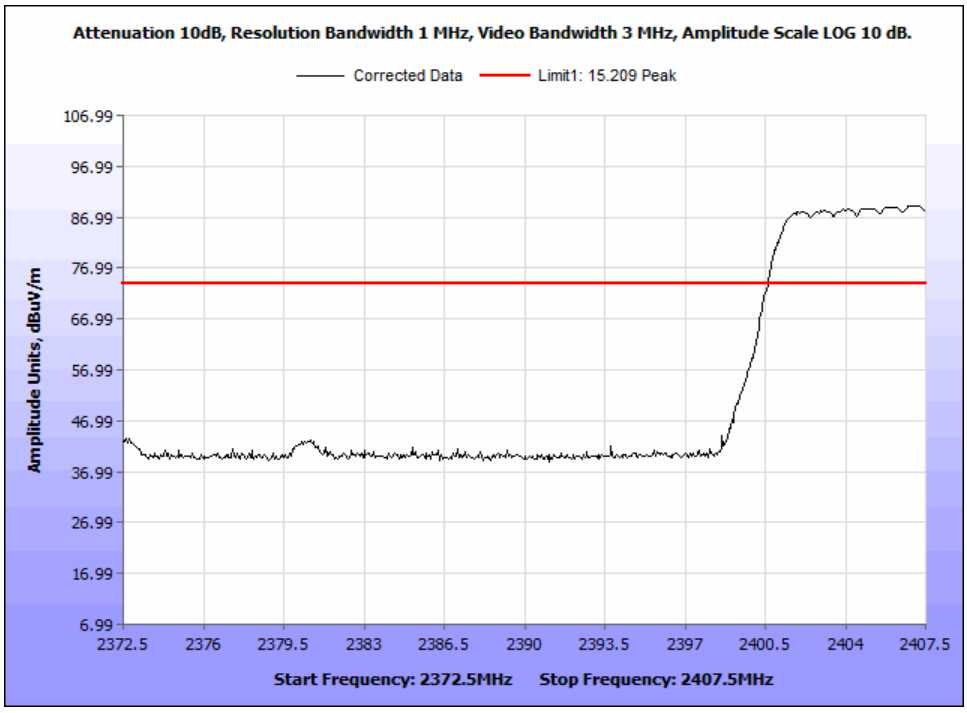

Figure 101: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2390M edge_2-DH1.

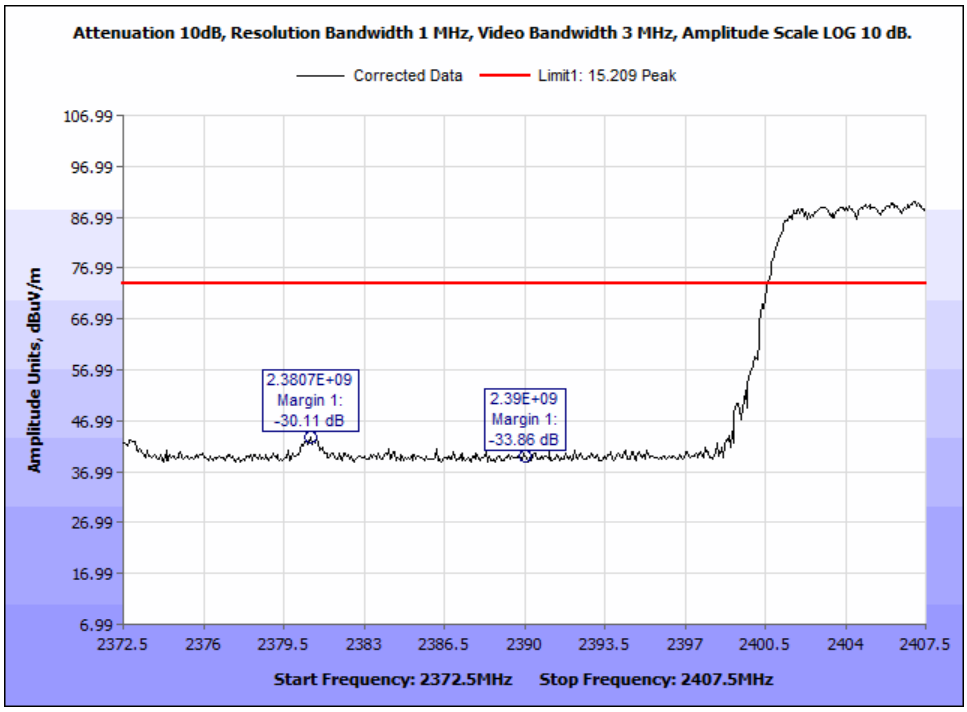

Figure 102: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2390M edge_3-DH1.

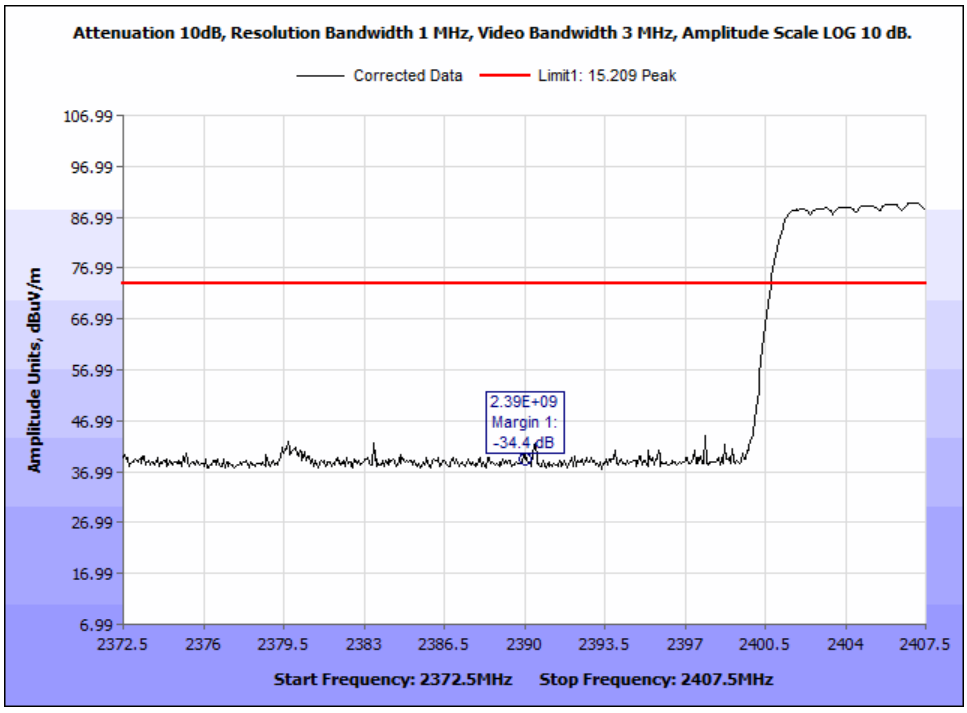

Figure 103: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2390M edge_DH1.

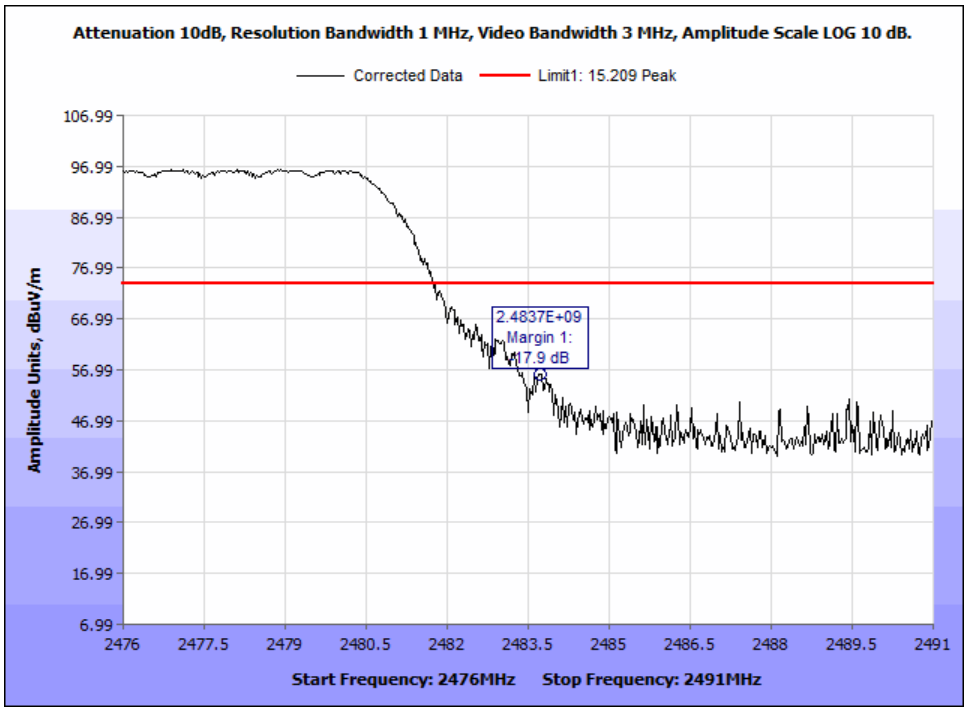

Figure 104: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2483.5M edge_2-DH1.

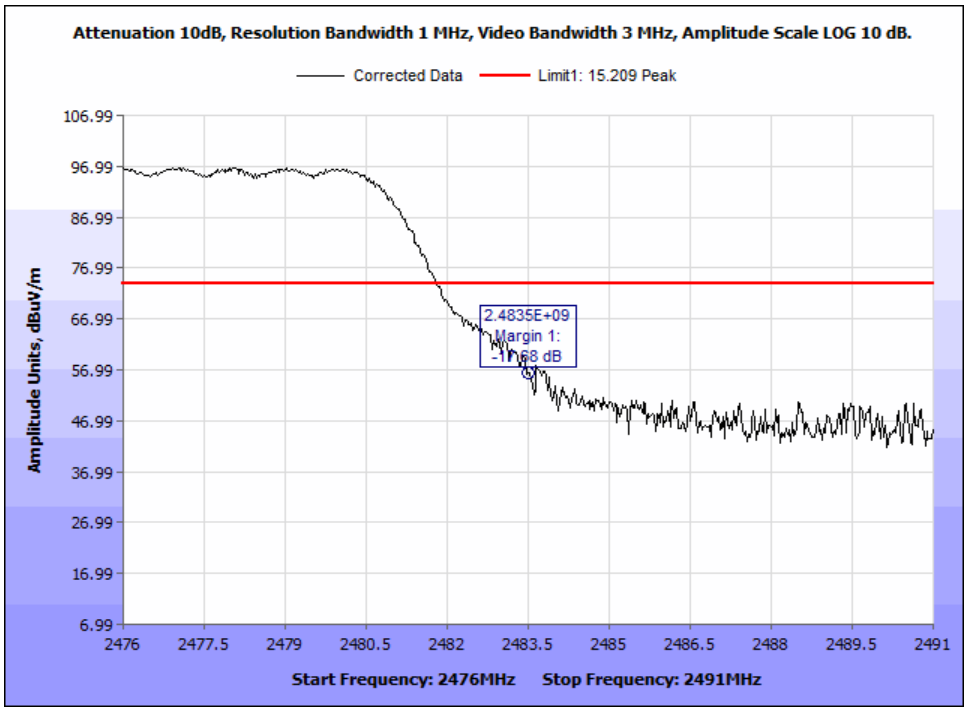

Figure 105: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2483.5M edge_3-DH1.

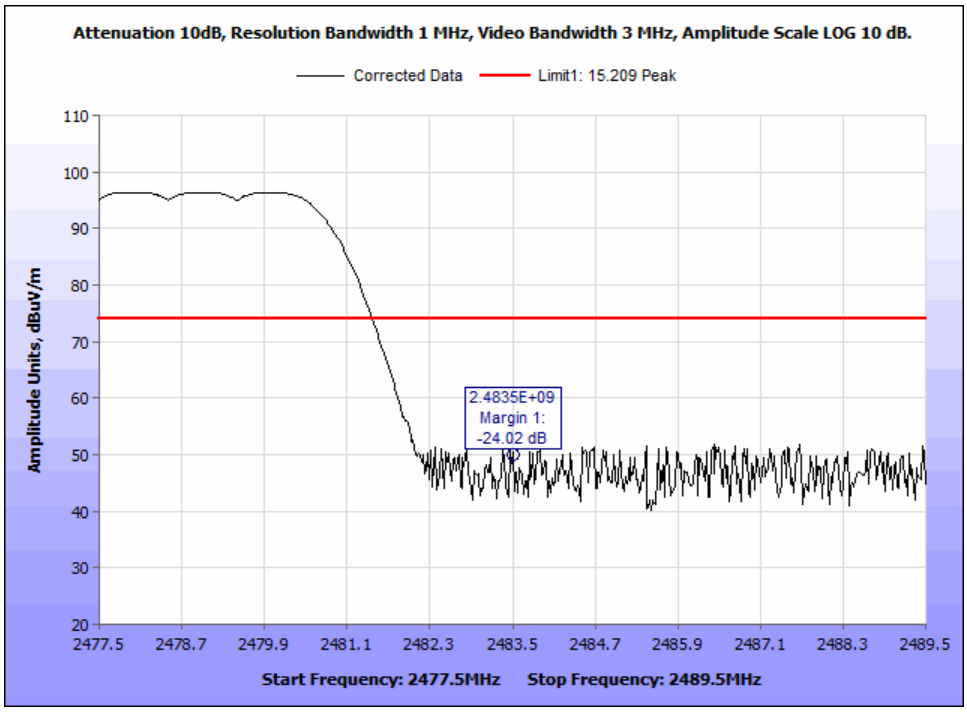

Figure 106: Radiated Spurious Emissions Requirements and Band Edge, PK_hopping radiated bandedge_2483.5M edge_DH1.

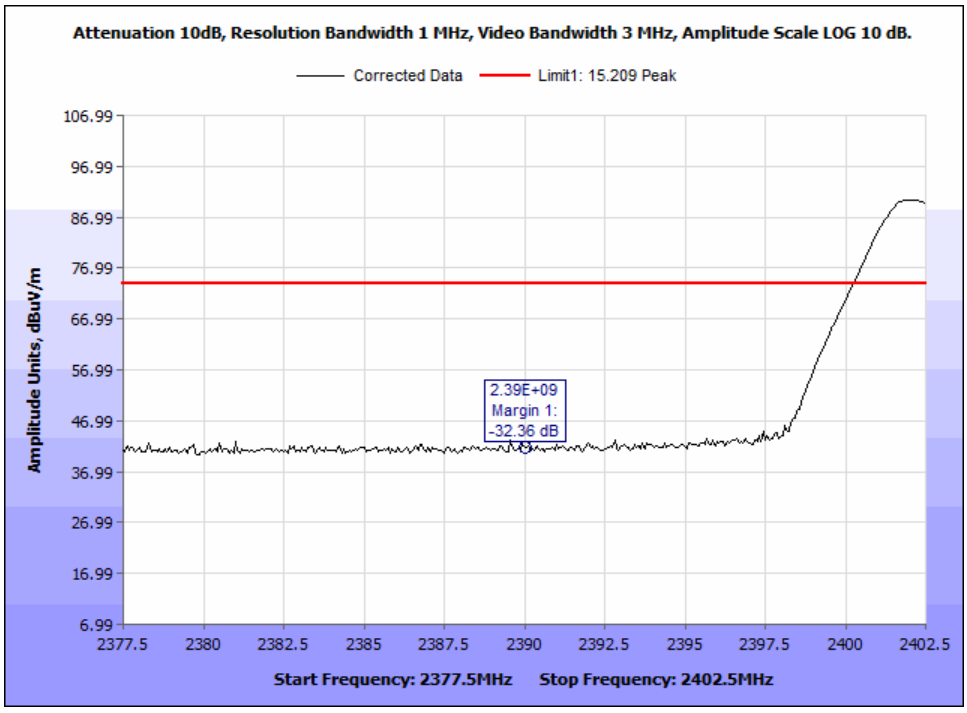

Figure 107: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2390M edge_2-DH1_2402MHz.

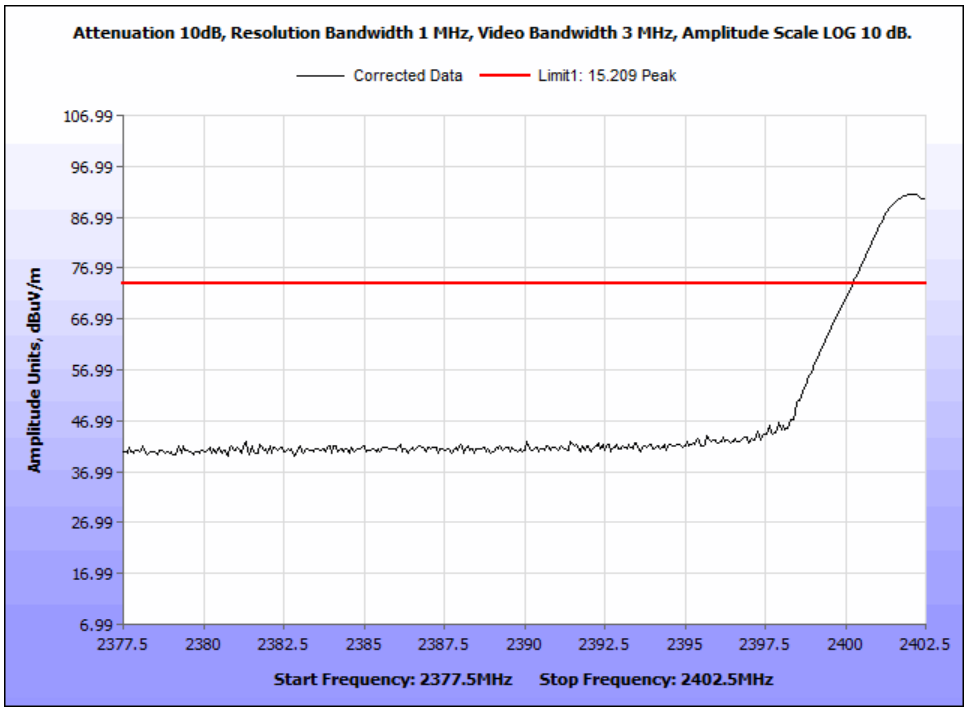

Figure 108: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2390M edge_3-DH1_2402MHz.

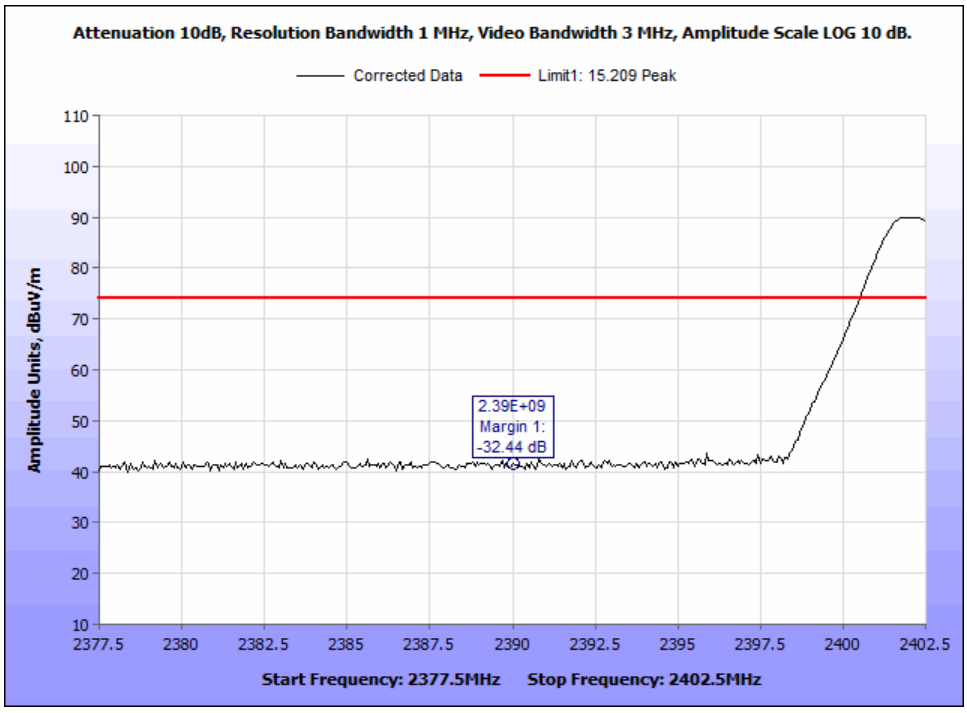

Figure 109: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2390M edge_DH1_2402MHz.

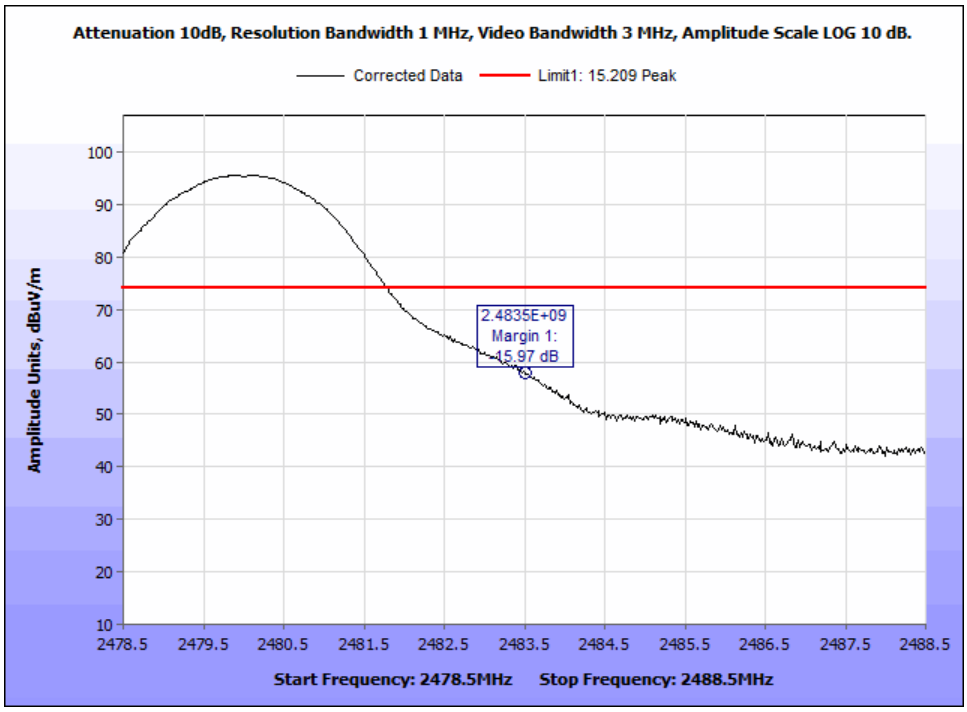

Figure 110: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2483.5M edge_2-DH1_2480MHz.

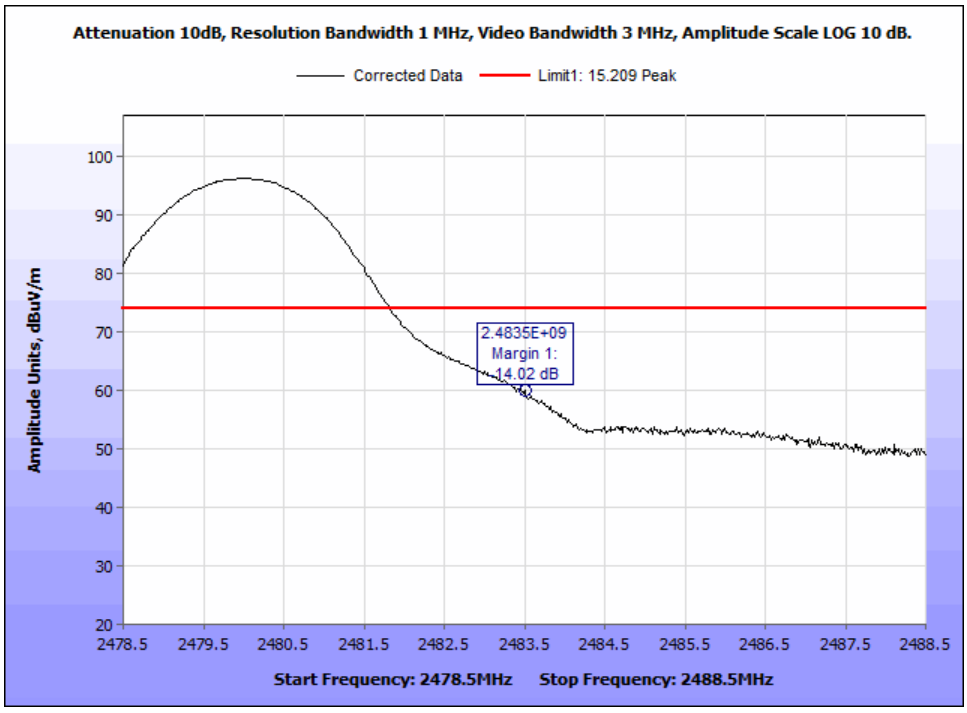

Figure 111: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2483.5M edge_3-DH1_2480MHz.

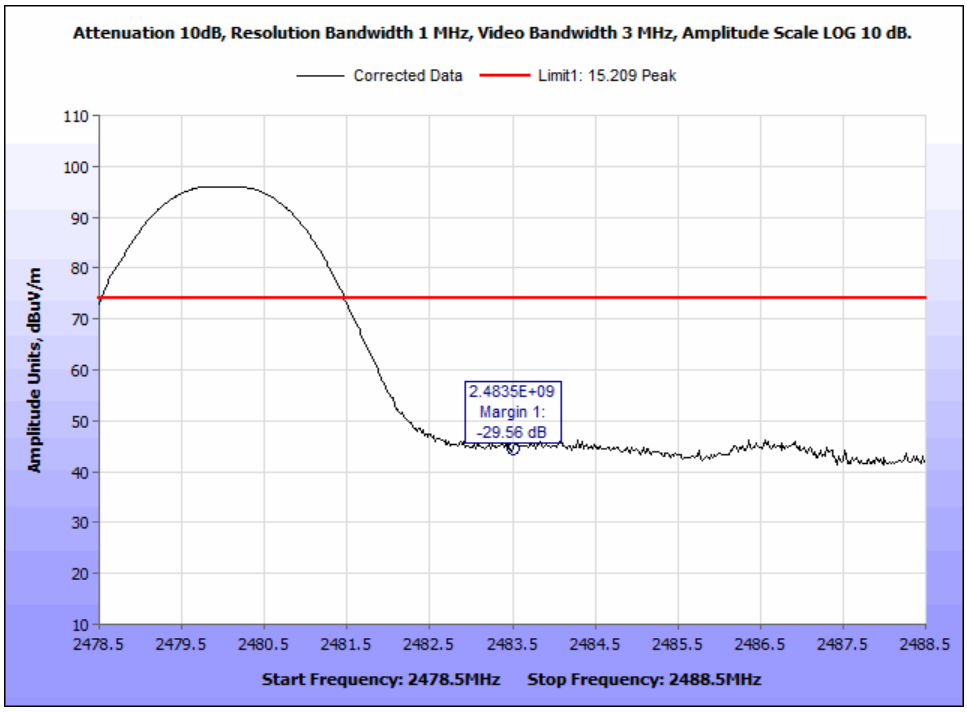

Figure 112: Radiated Spurious Emissions Requirements and Band Edge, PK_radiated bandedge_2483.5M edge_DH1_2480MHz.

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(d) RF Conducted Spurious Emissions Requirements and Band Edge

Test Requirement: **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Test Procedure: For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Since the EUT had an integral antenna, conducted measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable lost.

See following pages for detailed test results with RF Conducted Spurious Emissions.

Test Results: The EUT was **compliant** to the requirement(s) of this section. No anomalies noted.

Test Engineer: Donald Salguero

Test Date: March 25, 2020

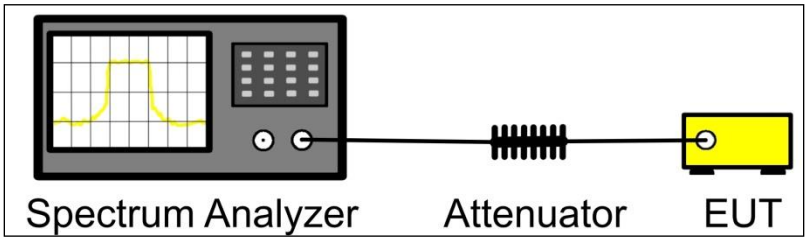

Figure 113: Conducted Spurious Emissions Test Setup

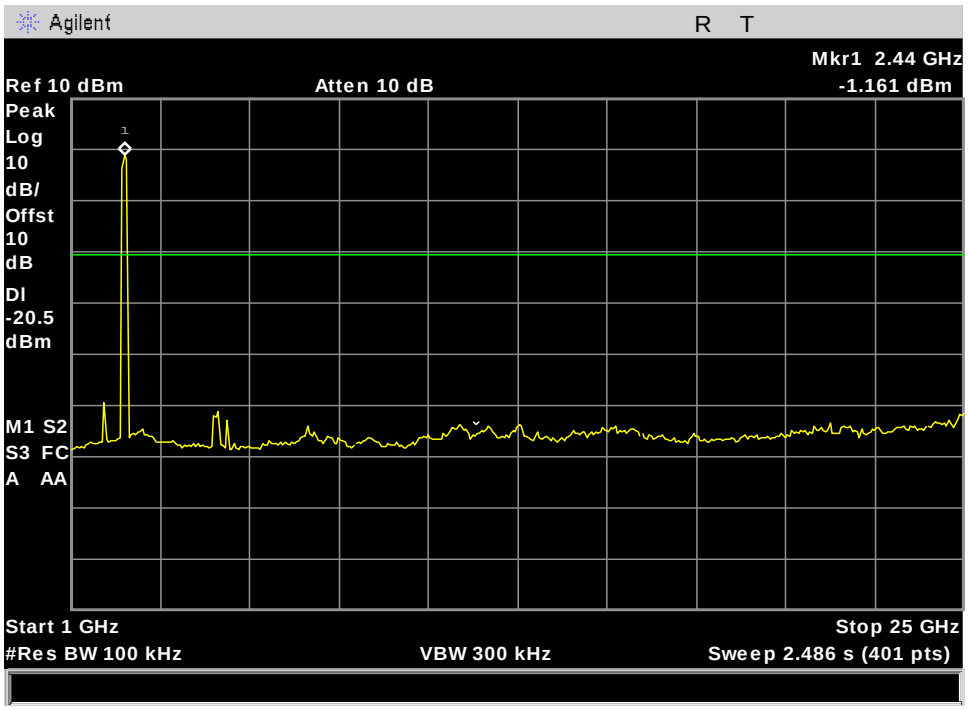

Figure 114: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1 hopping_1-25GHz

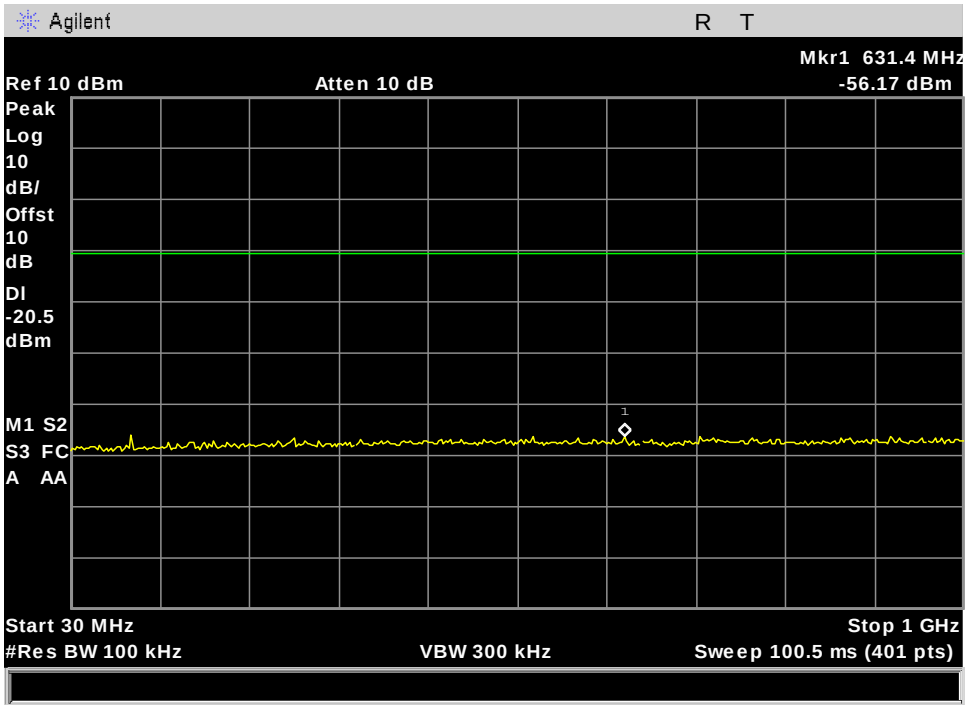

Figure 115: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1 hopping_30-1000MHz

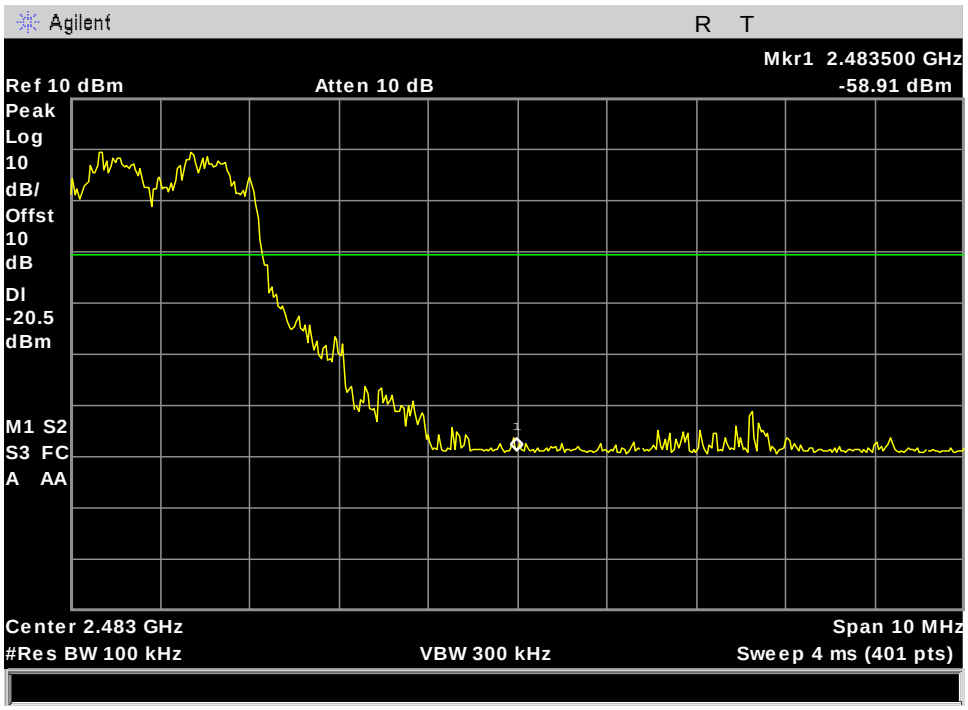

Figure 116: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1 hopping_high band edge

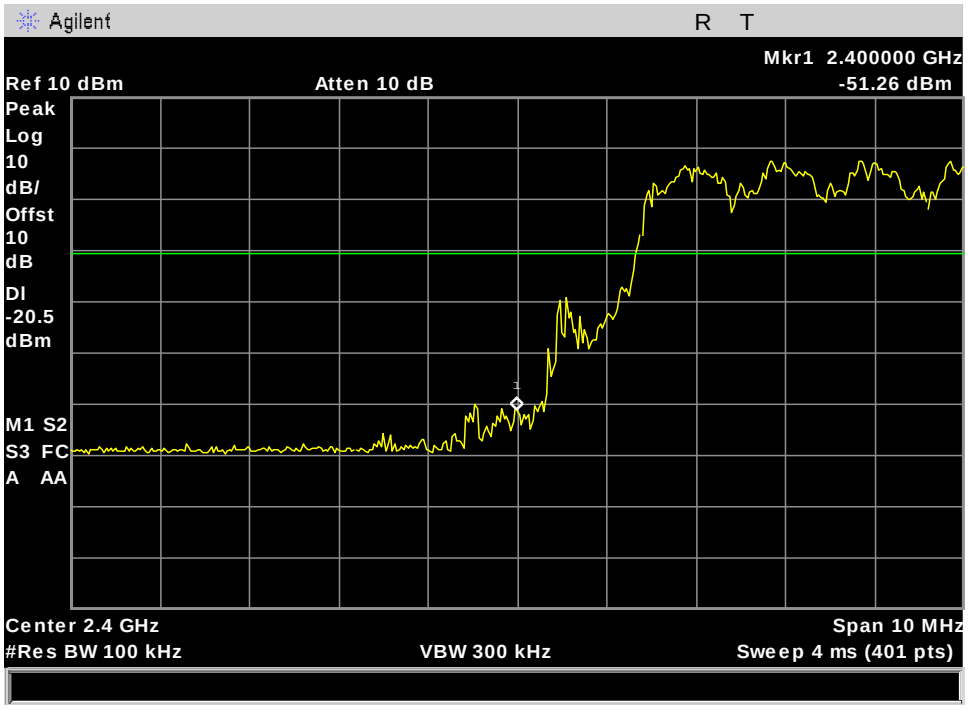

Figure 117: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1 hopping_low band edge

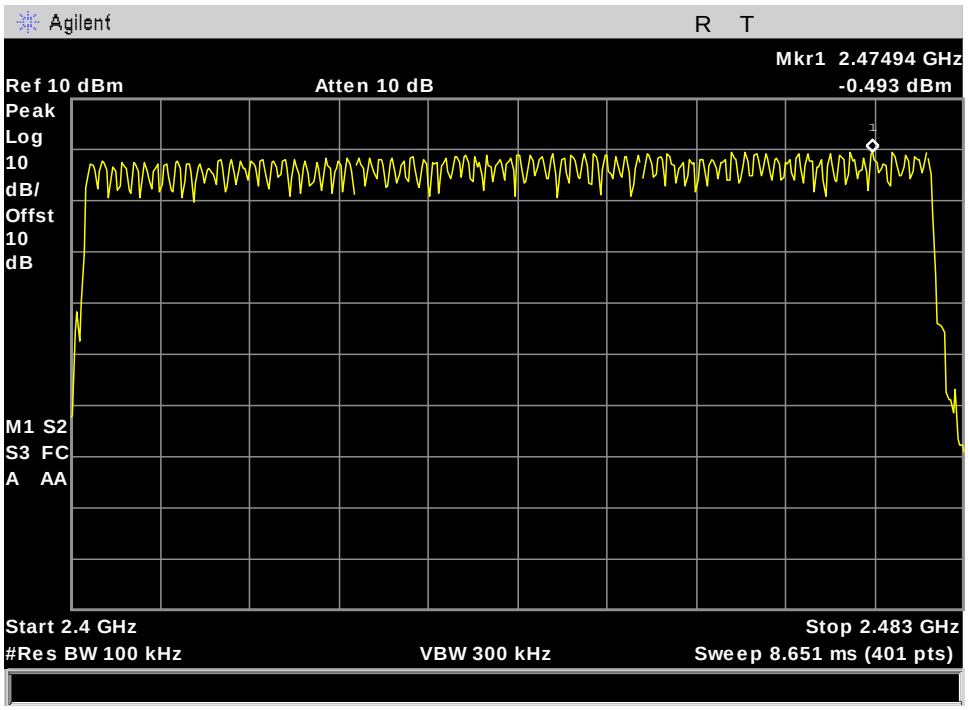

Figure 118: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1 hopping_reference level

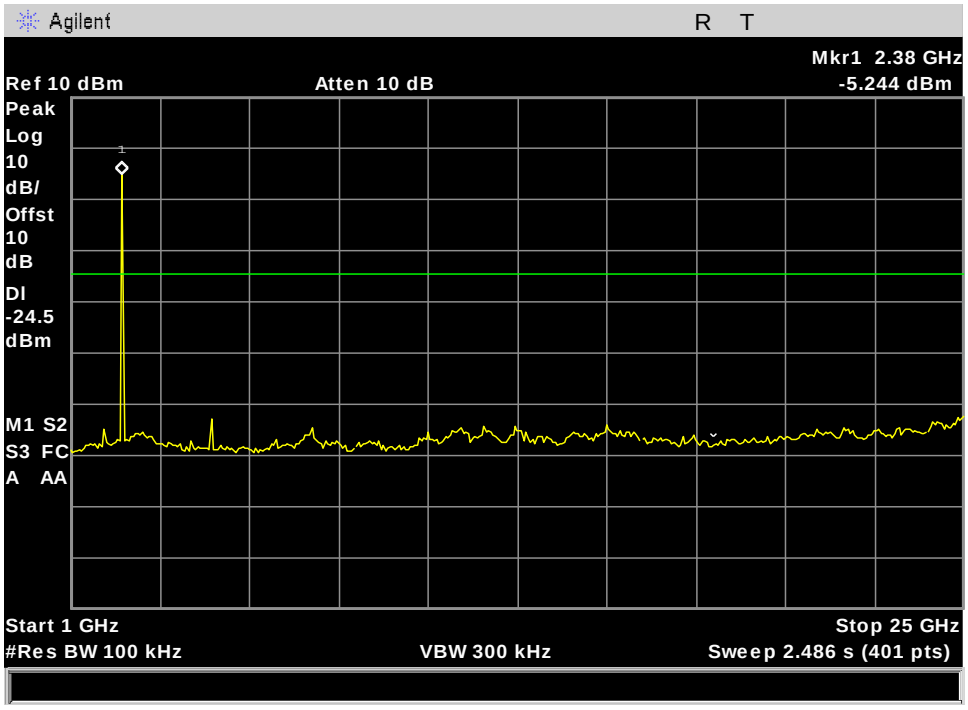

Figure 119: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2402_1-25GHz

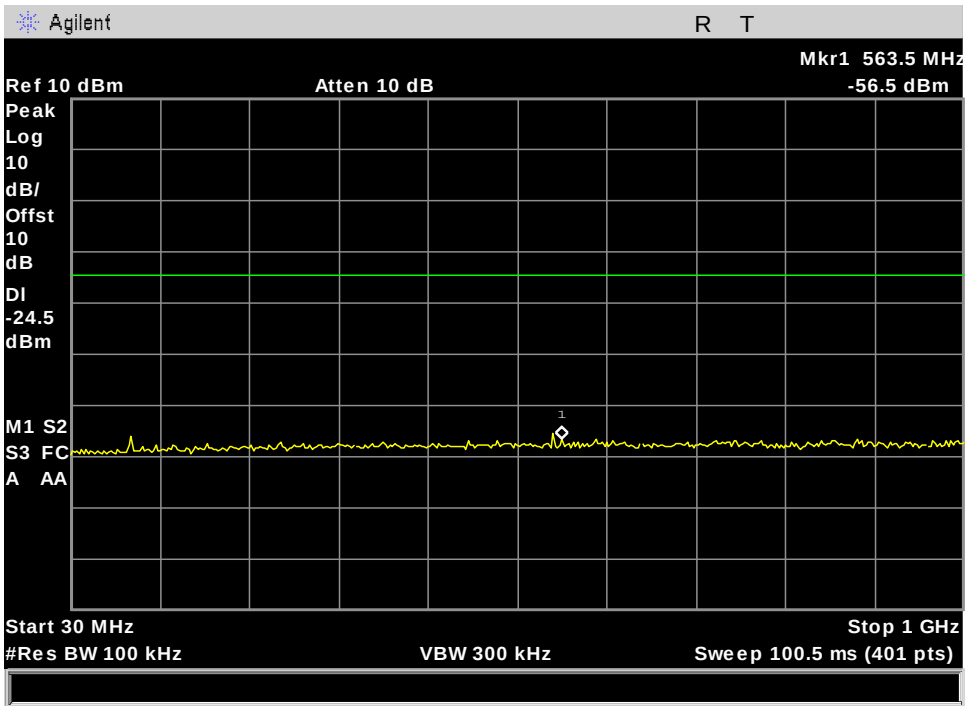

Figure 120: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2402_30-1000MHz

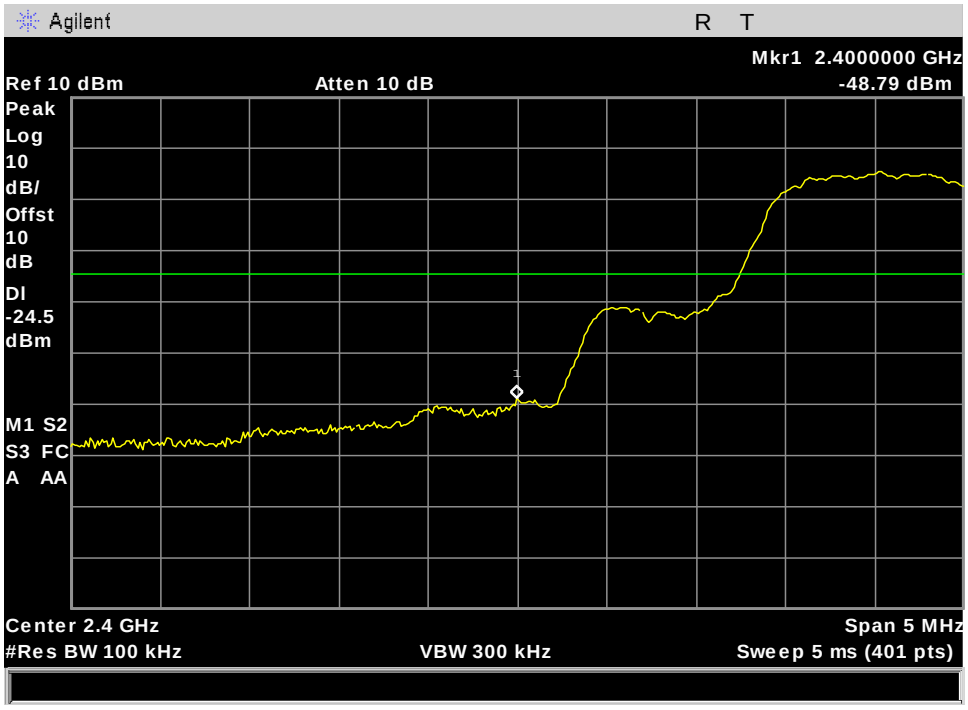

Figure 121: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2402_low band edge

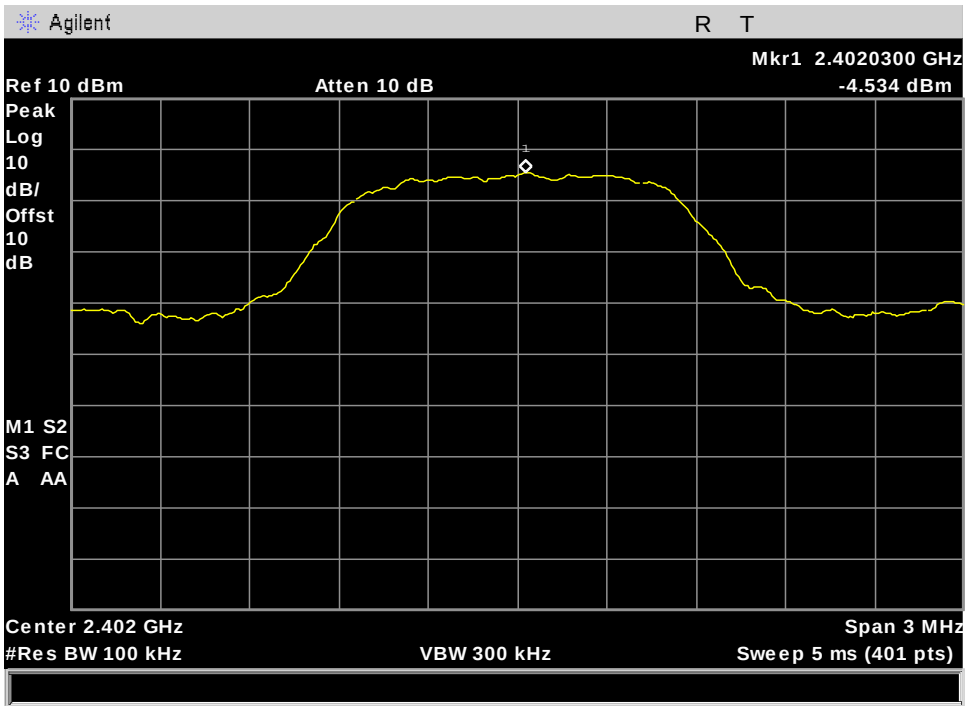

Figure 122: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2402_reference level

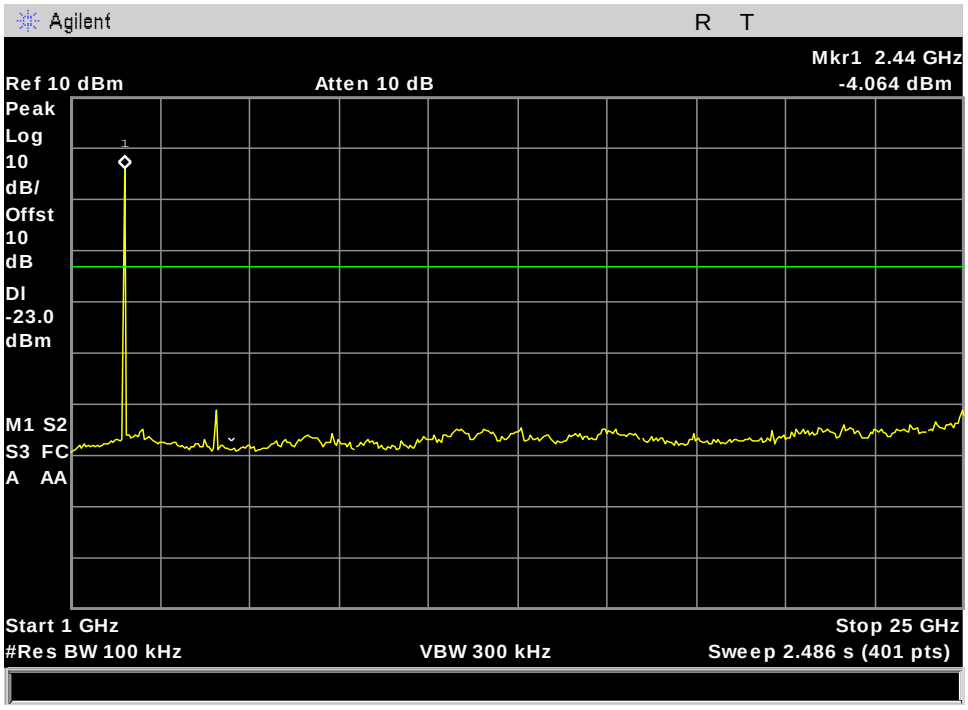

Figure 123: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2441_1-25GHz

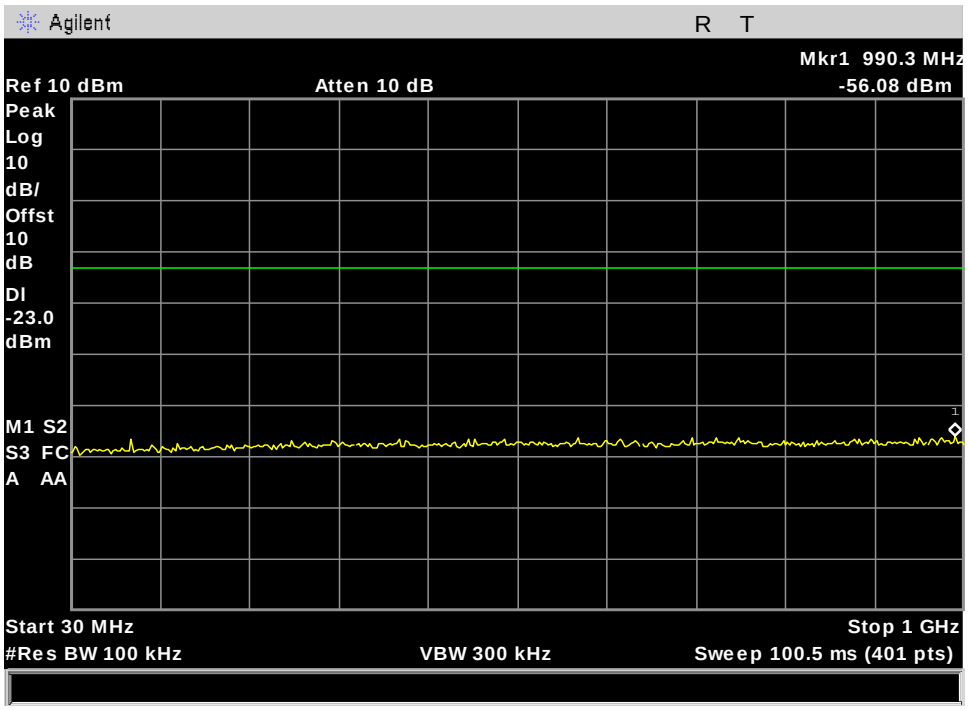

Figure 124: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2441_30-1000MHz

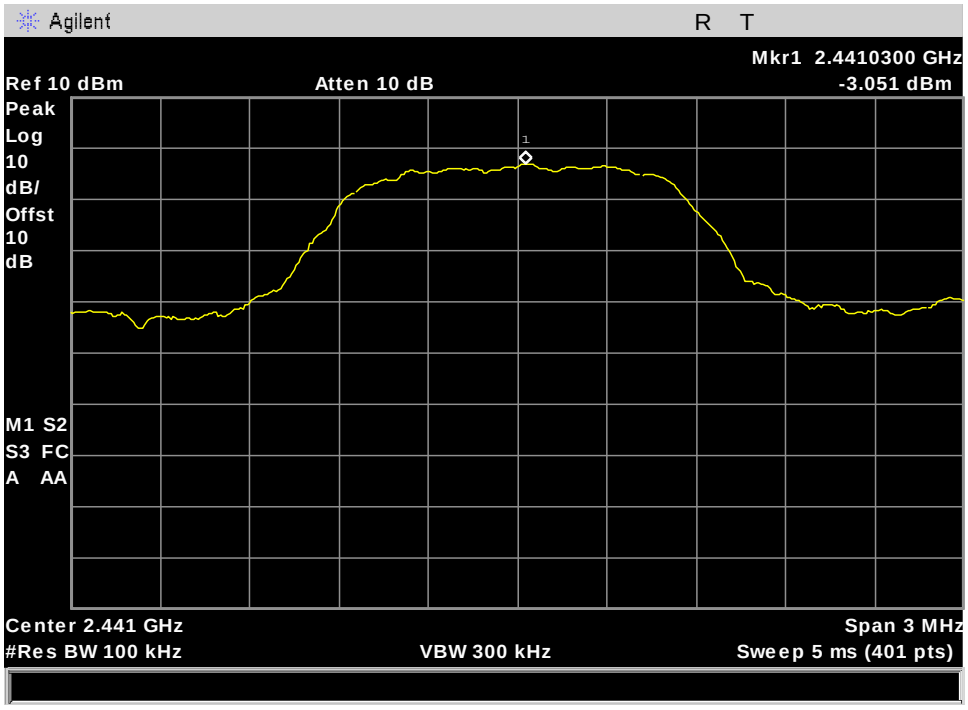

Figure 125: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2441_reference level

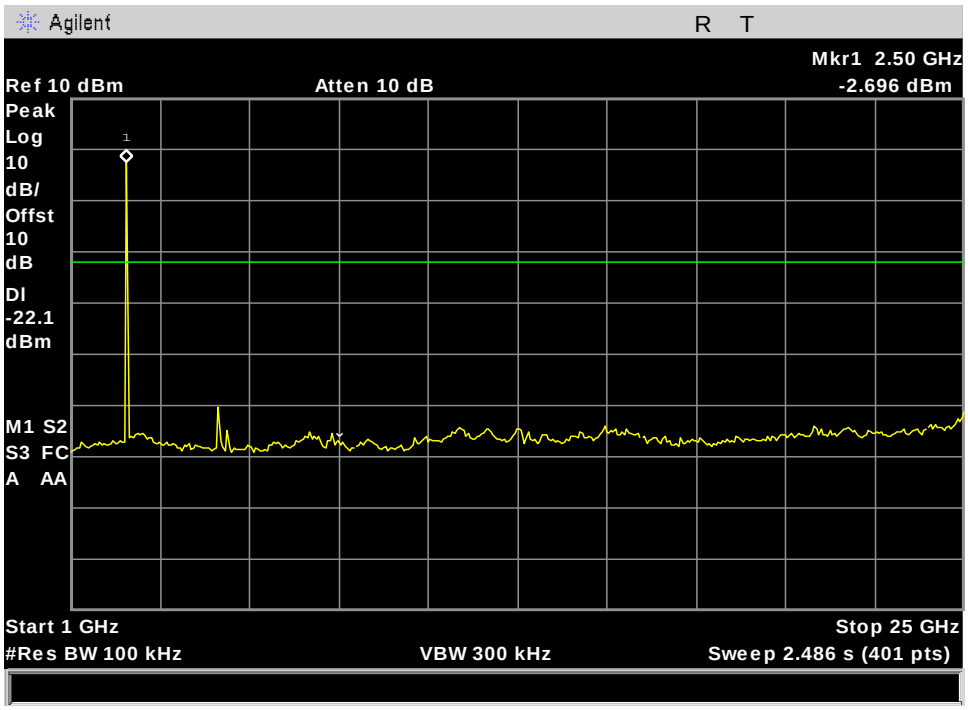

Figure 126: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2480_1-25GHz

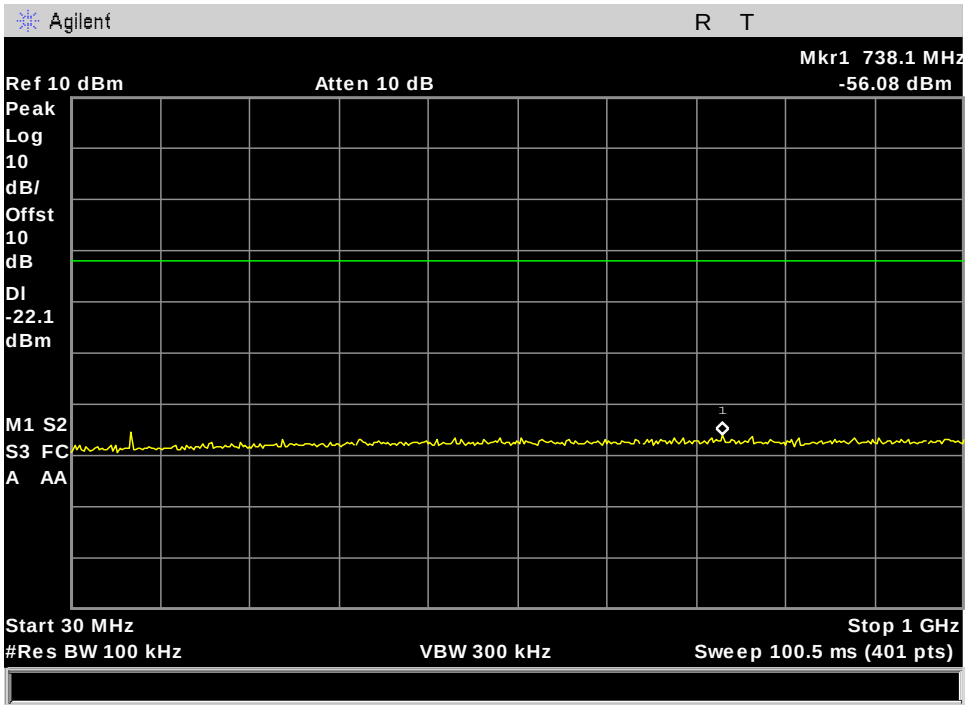

Figure 127: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2480_30-1000MHz

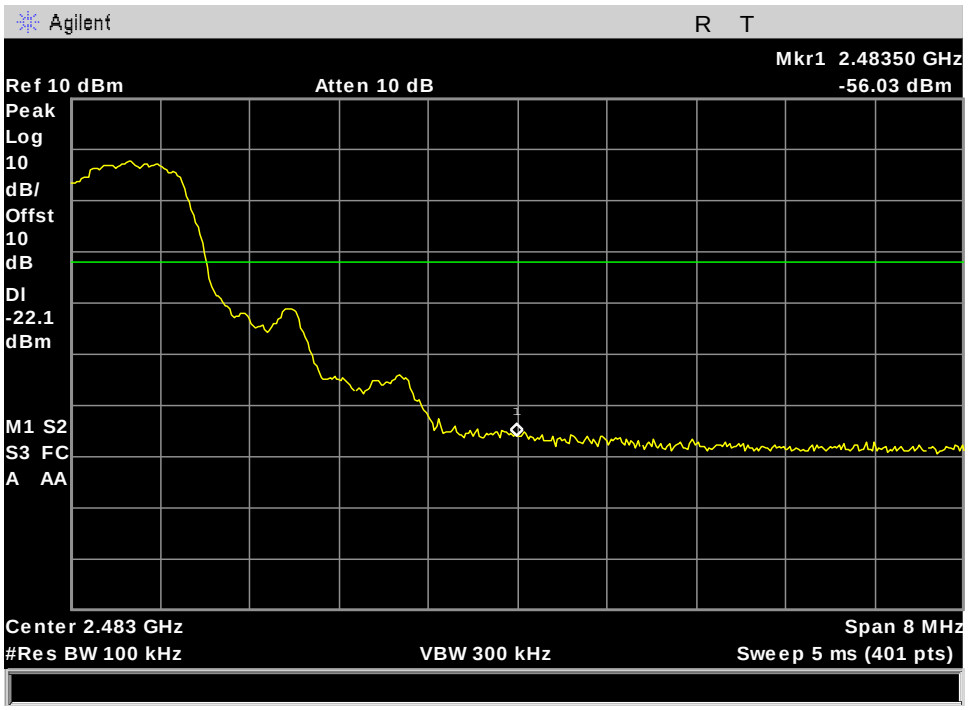

Figure 128: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2480_high band edge

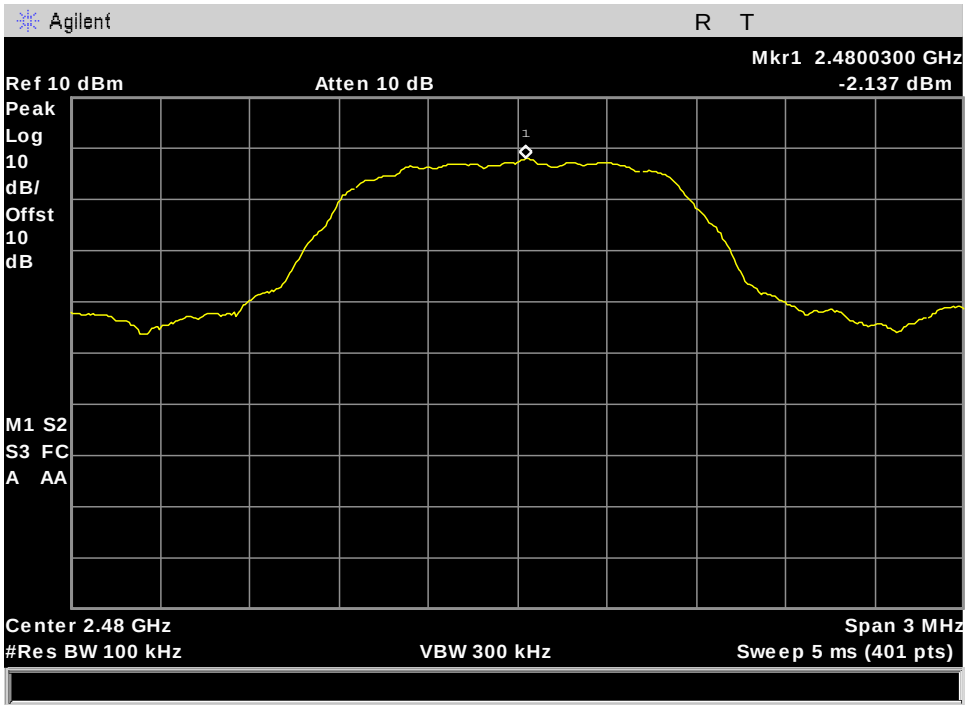

Figure 129: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_2-DH1_2480_reference level

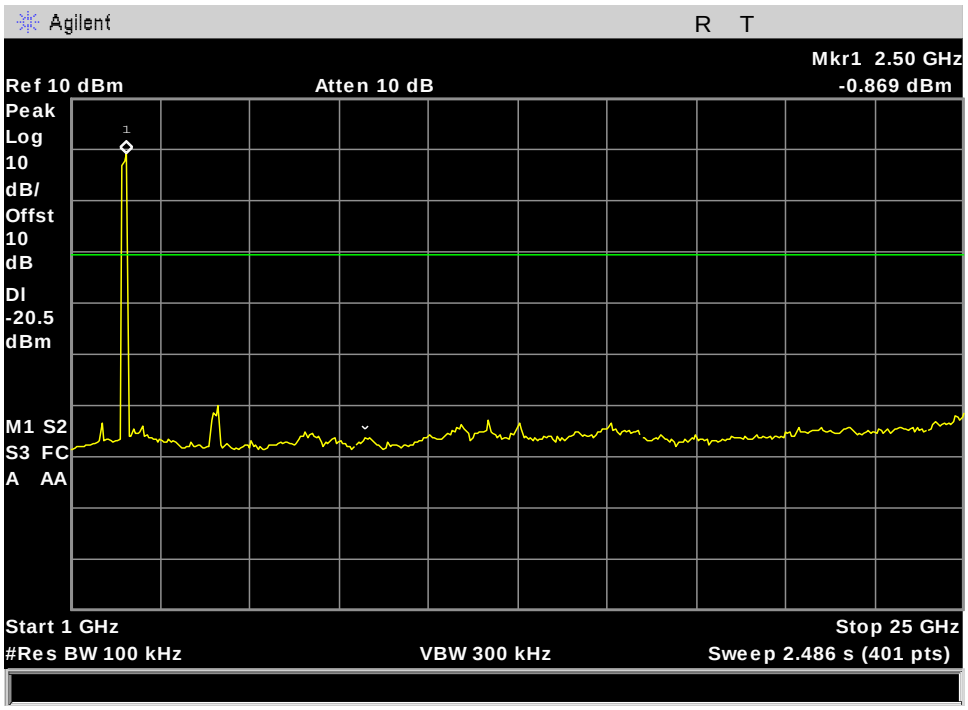

Figure 130: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1 hopping_1-25GHz

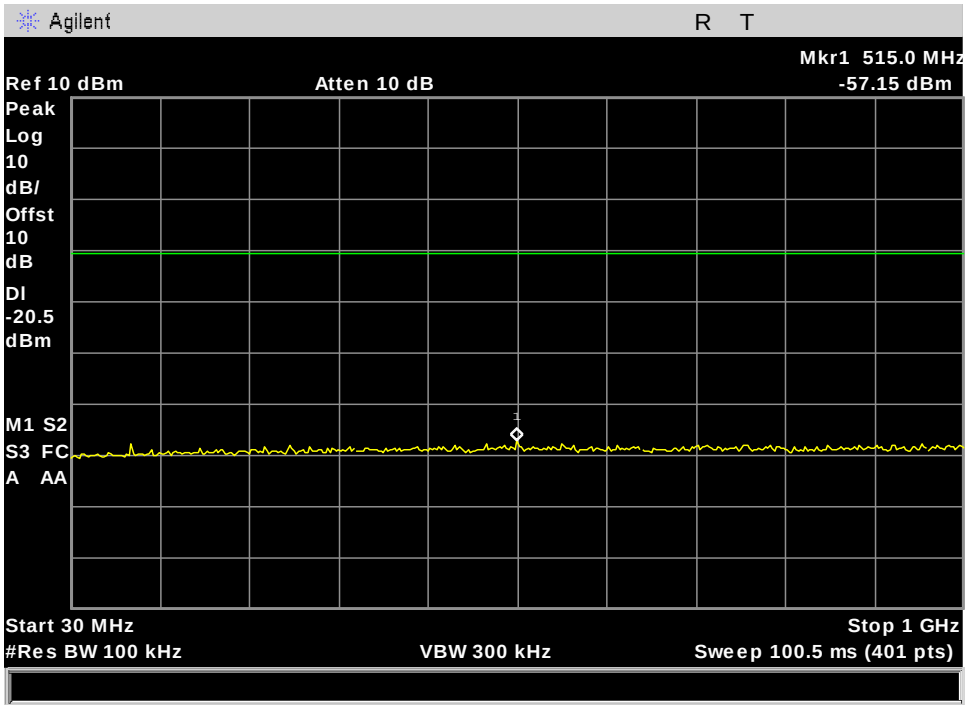

Figure 131: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1 hopping_30-1000MHz

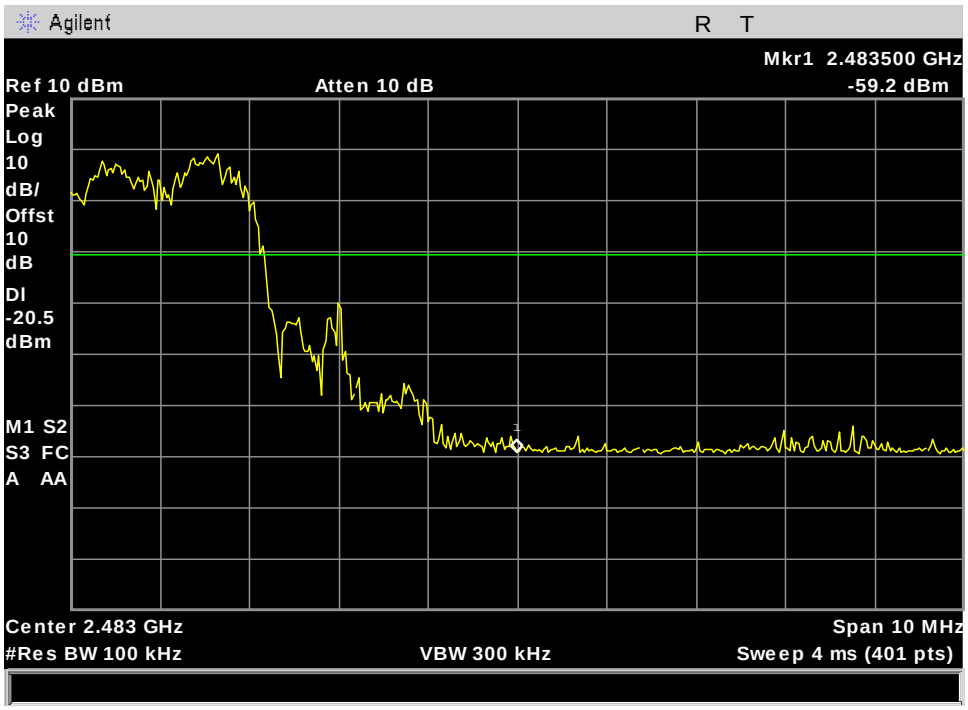

Figure 132: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1 hopping_high band edge

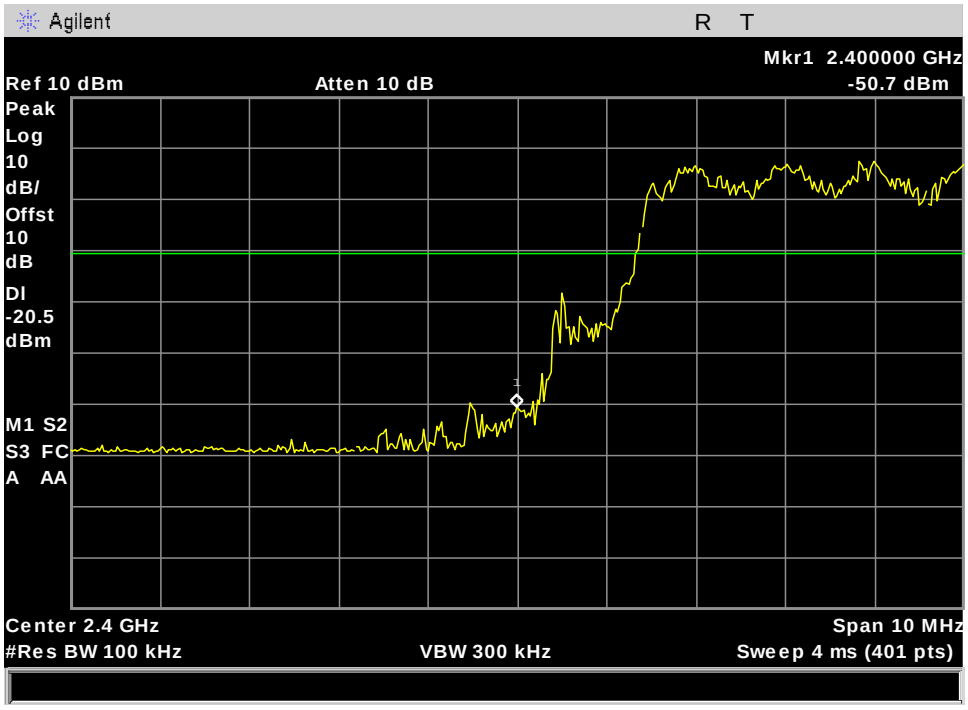

Figure 133: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1 hopping_low band edge

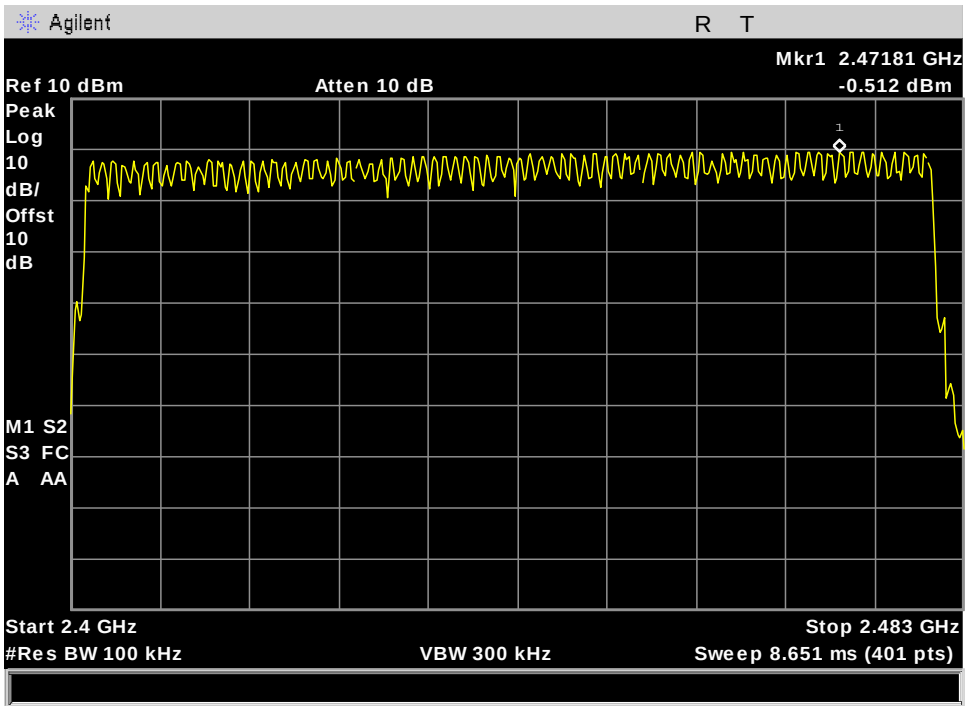

Figure 134: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1 hopping_reference level

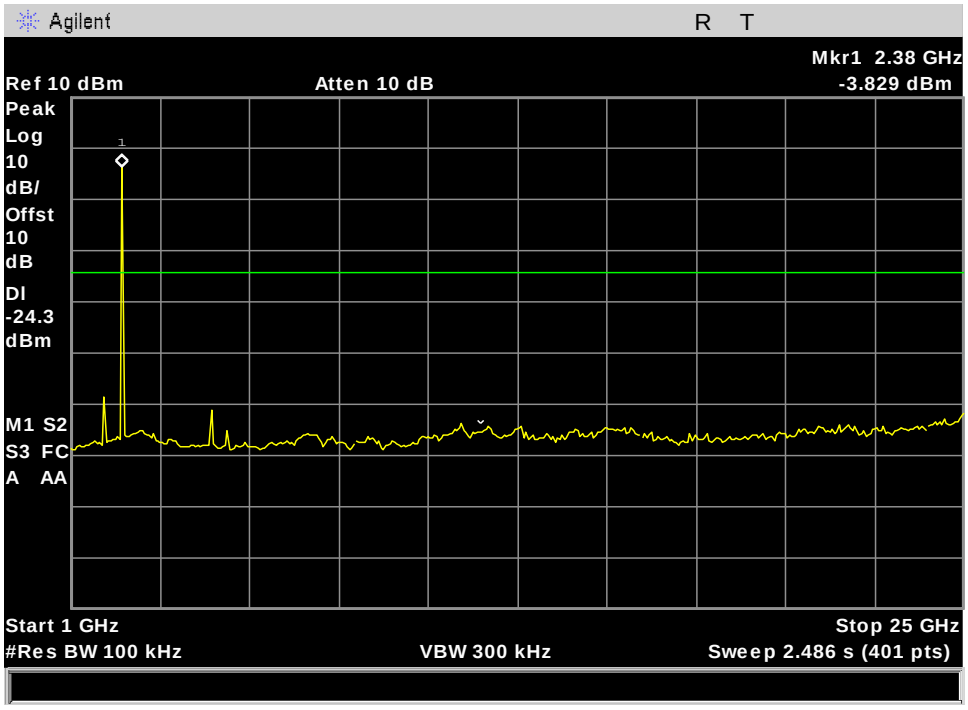

Figure 135: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2402_1-25GHz

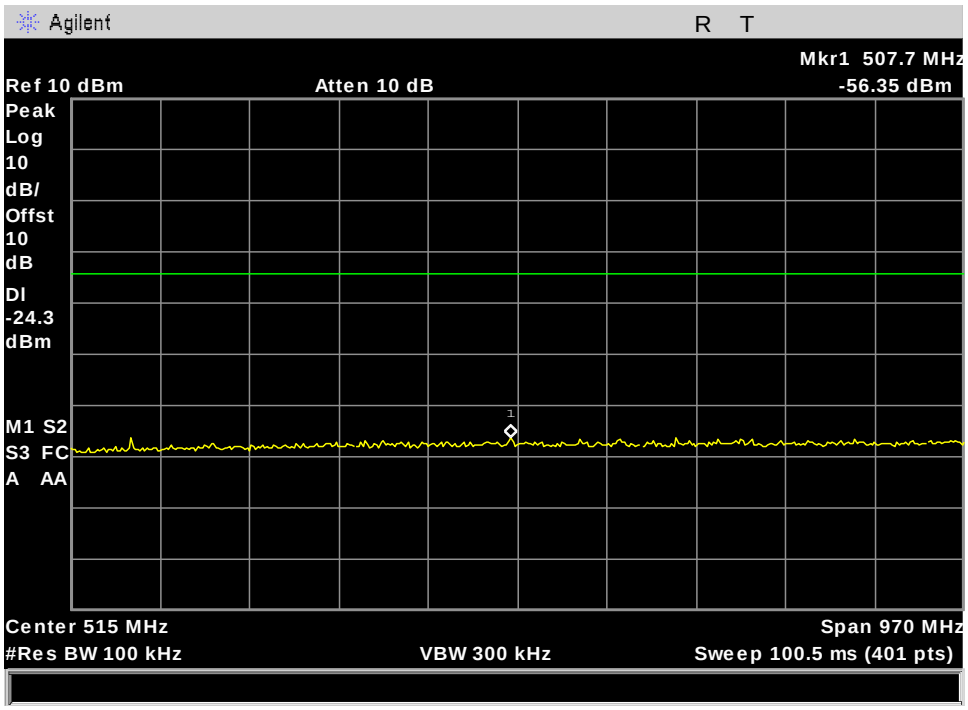

Figure 136: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2402_30-1000MHz

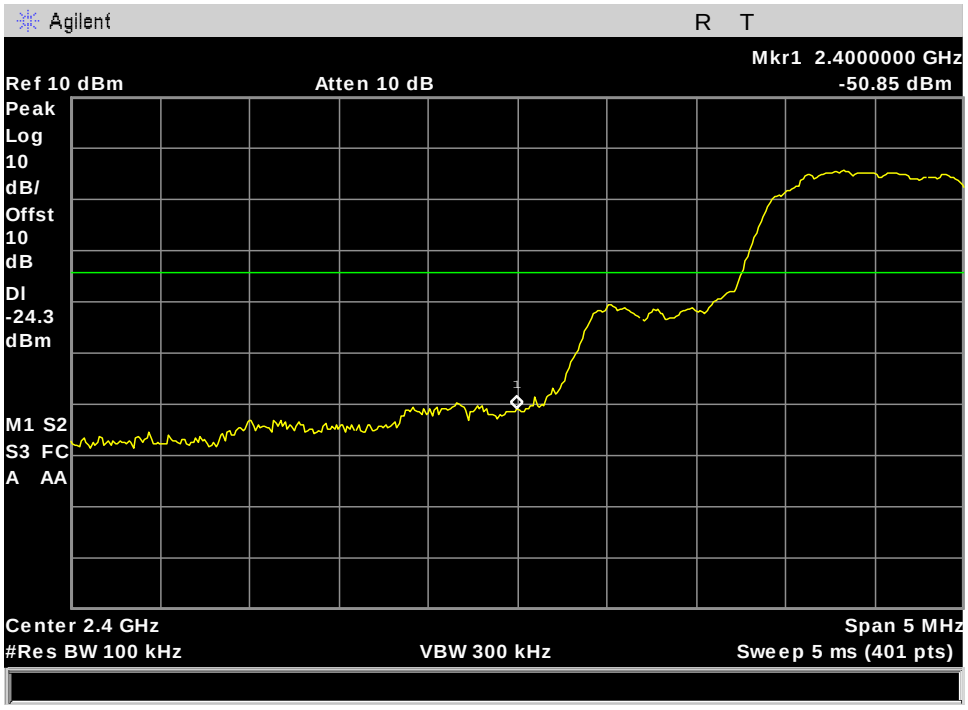

Figure 137: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2402_low band edge

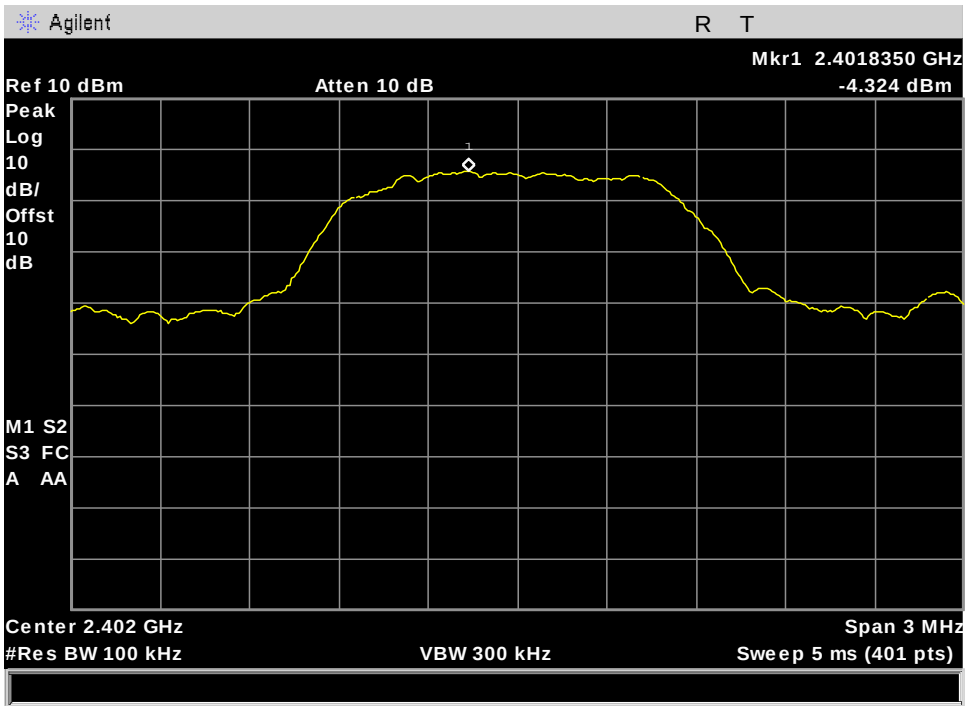

Figure 138: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2402_reference level

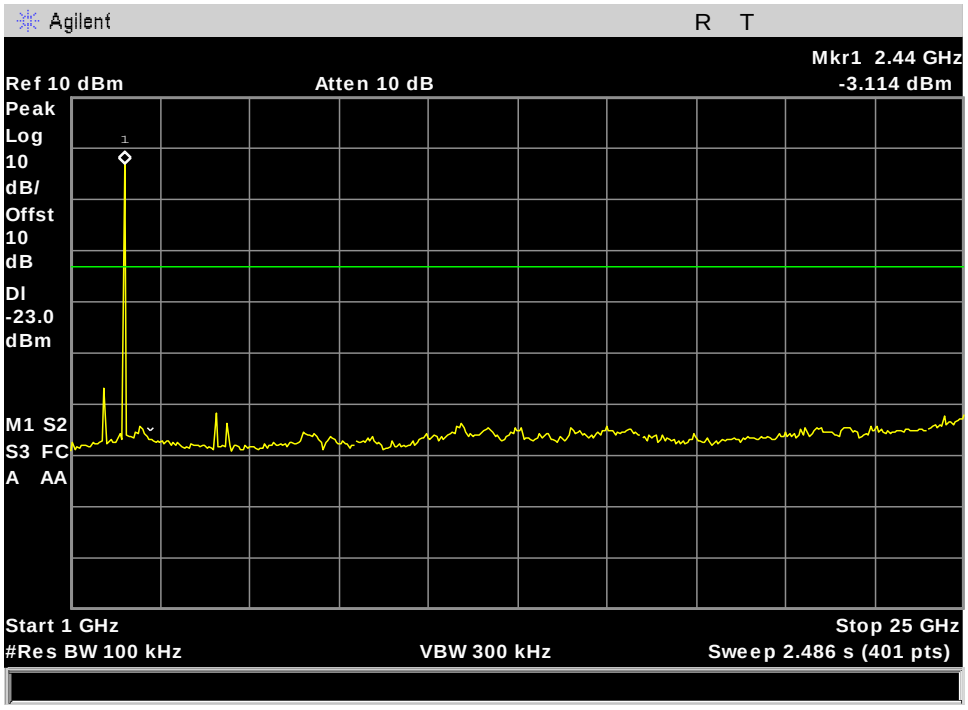

Figure 139: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2441_1-25GHz

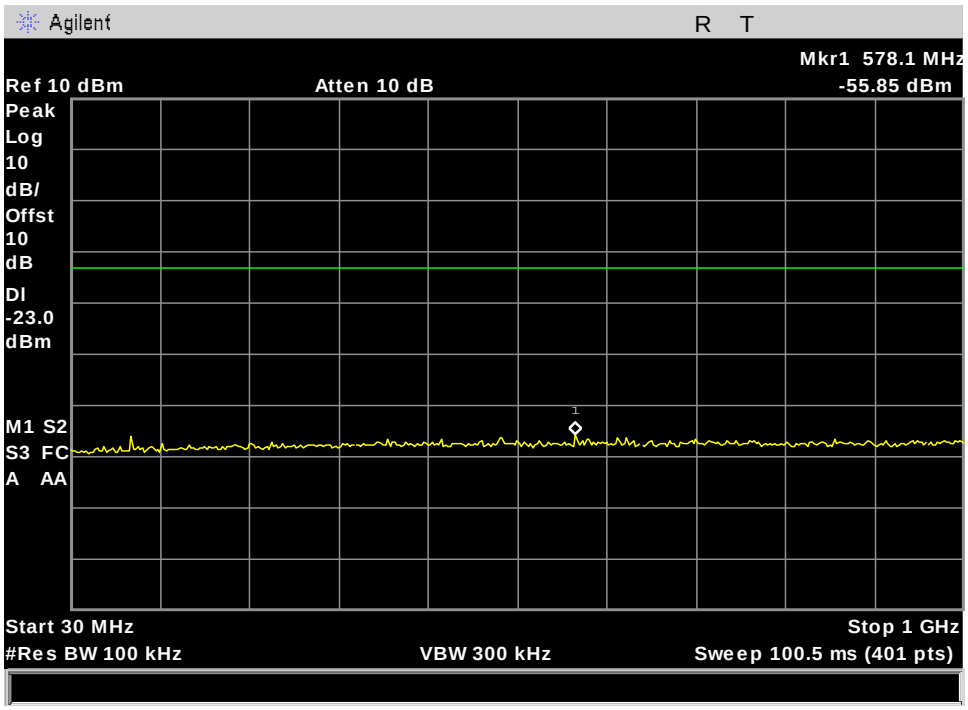

Figure 140: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2441_30-1000MHz

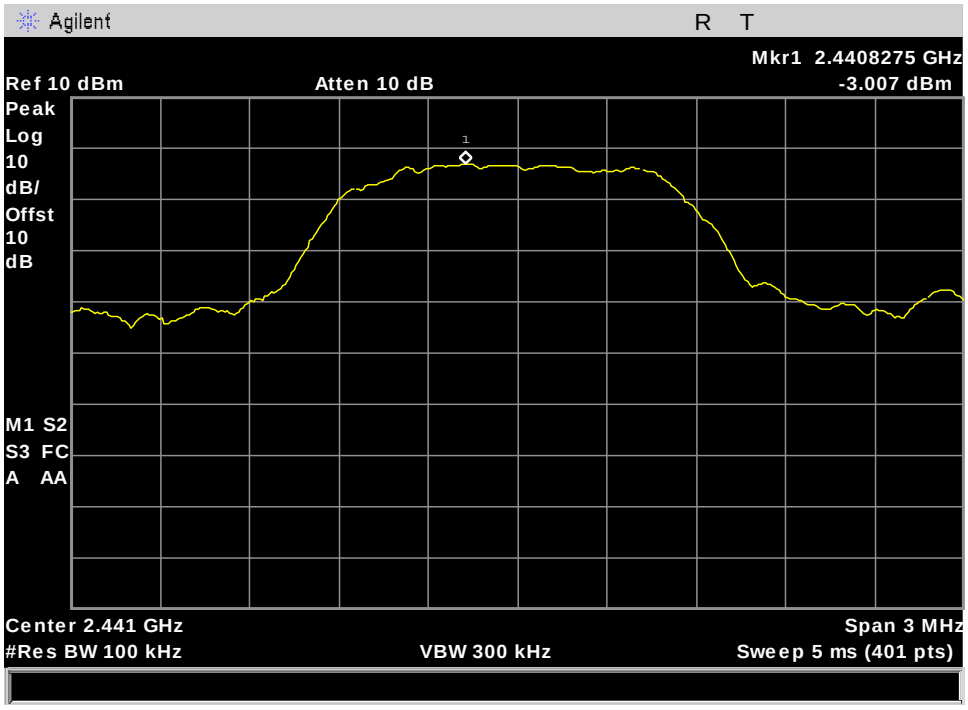

Figure 141: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2441_reference level

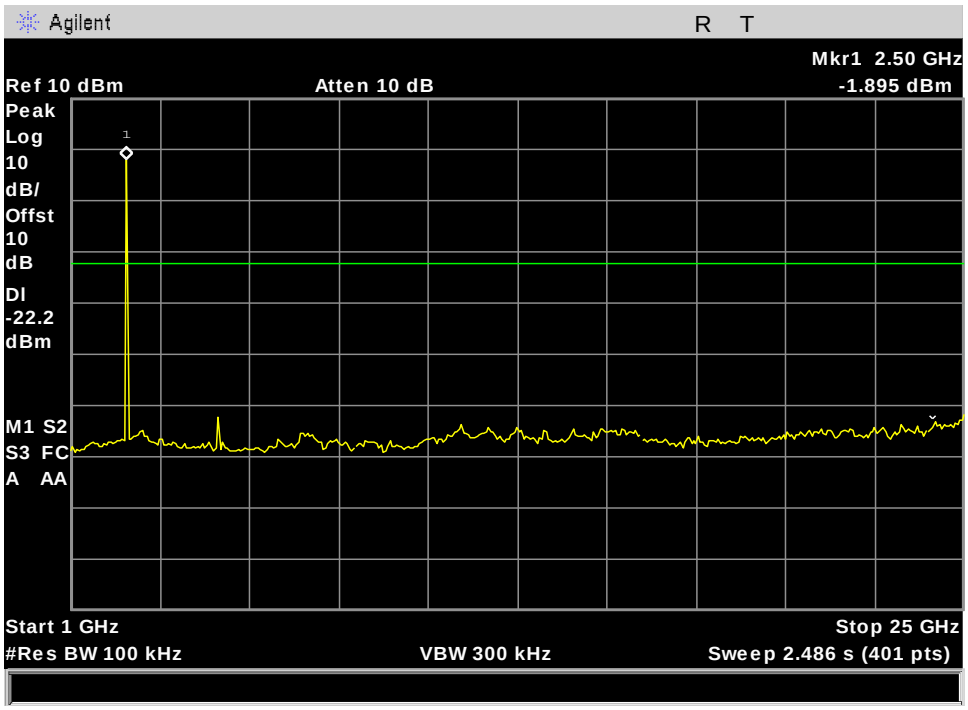

Figure 142: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2480_1-25GHz

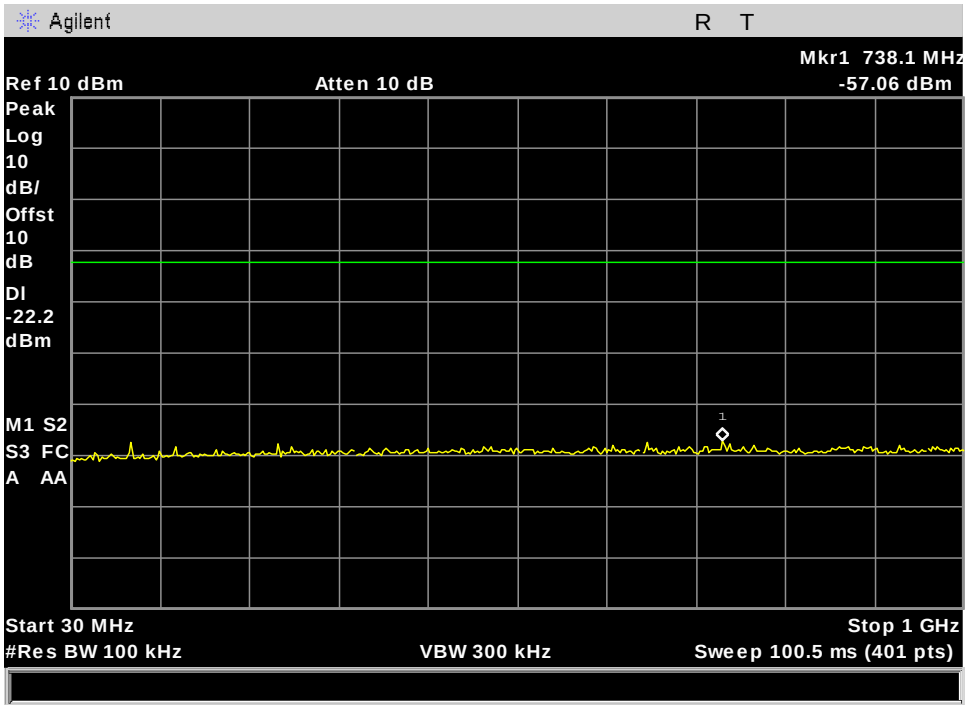

Figure 143: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2480_30-1000MHz

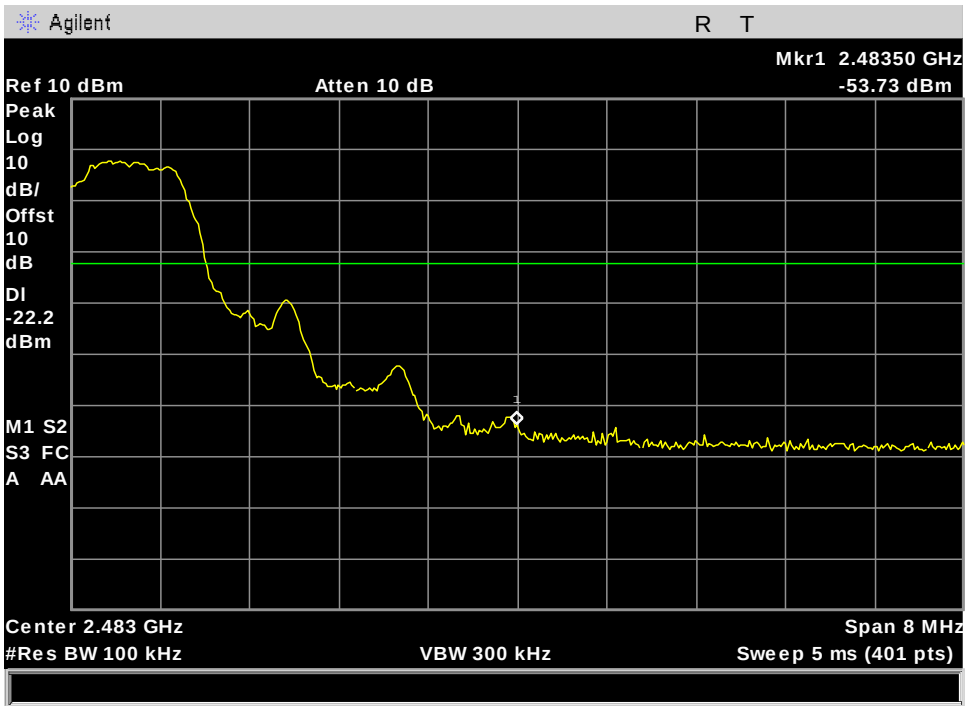

Figure 144: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2480_high band edge

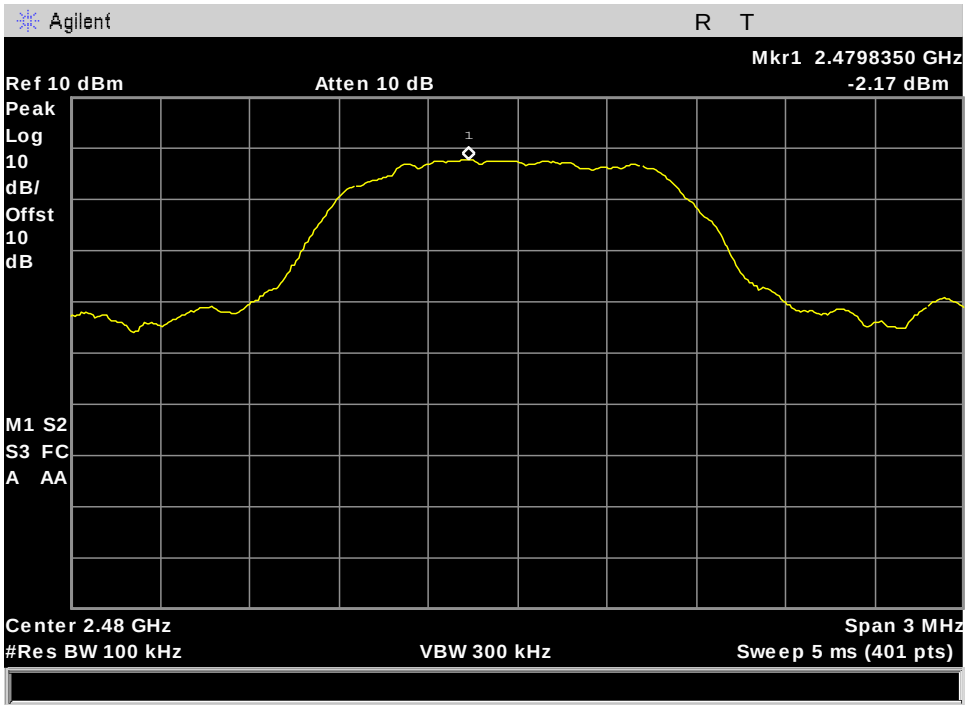

Figure 145: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_3-DH1_2480_reference level

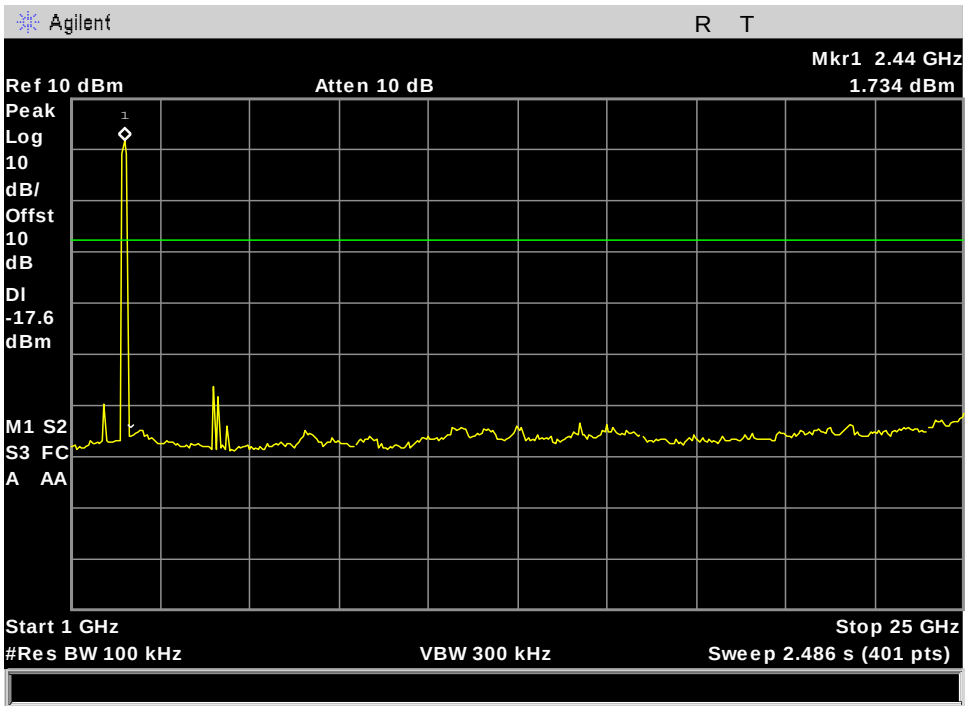

Figure 146: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1 hopping_1-25GHz

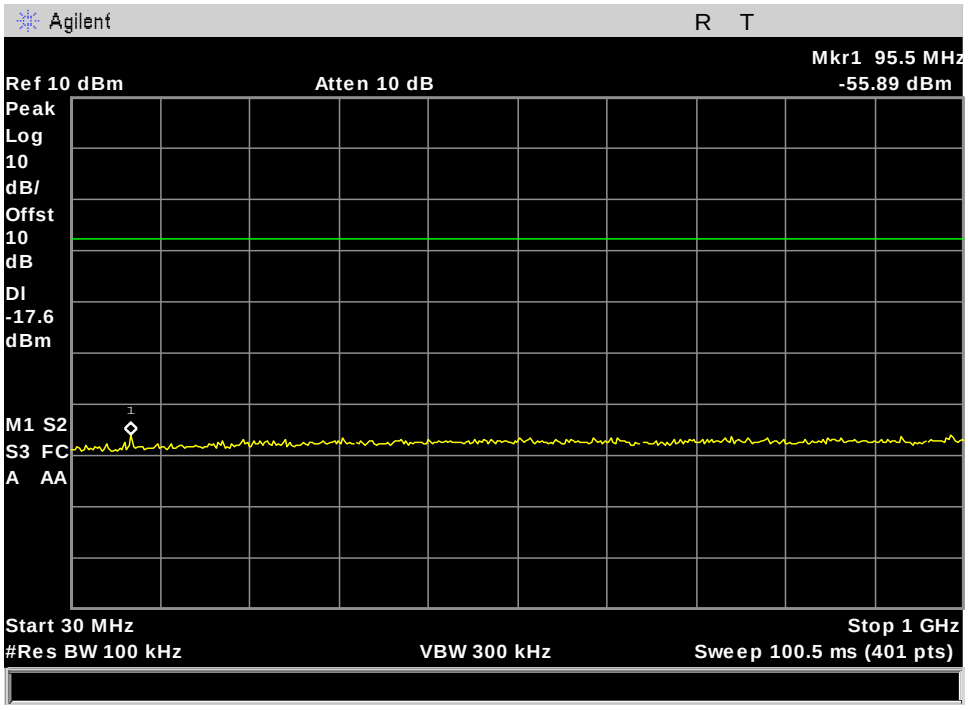

Figure 147: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1 hopping_30-1000MHz

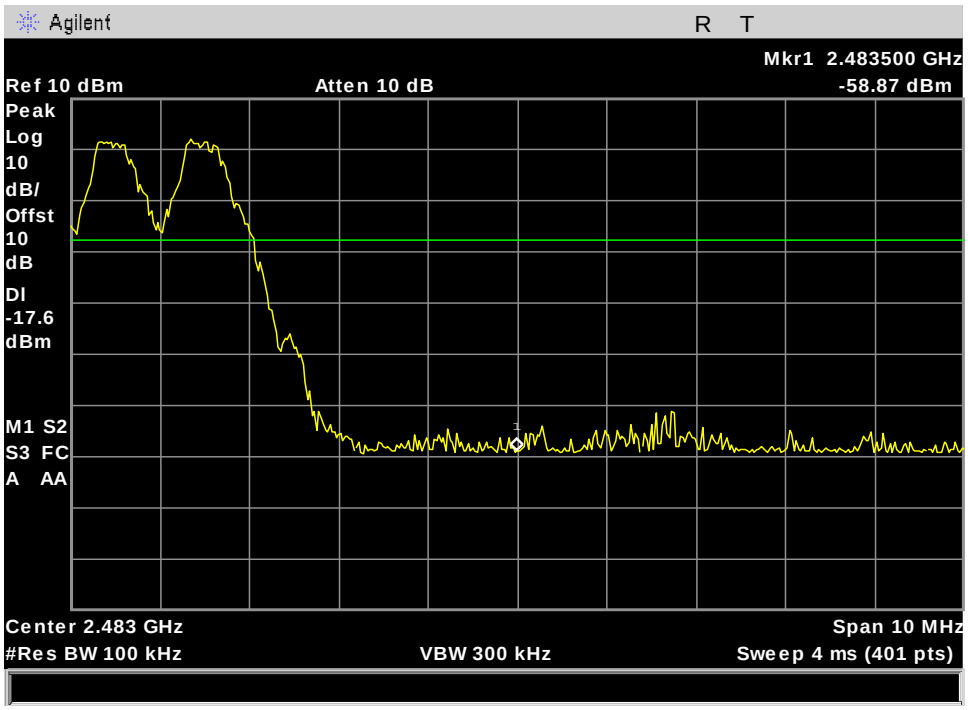

Figure 148: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1 hopping_high band edge

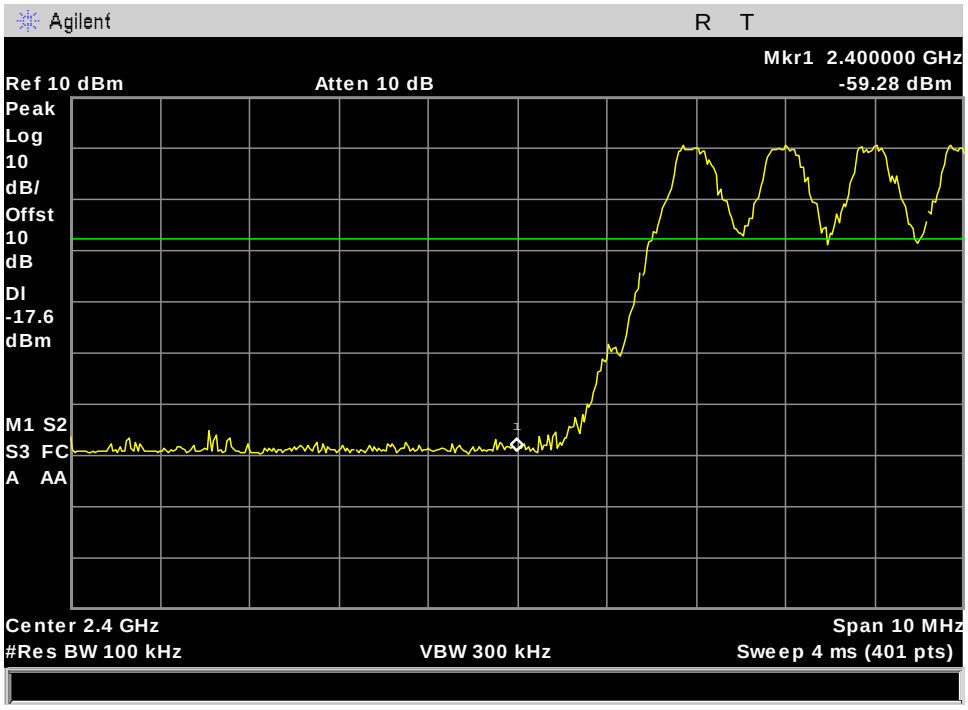

Figure 149: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1 hopping_low band edge

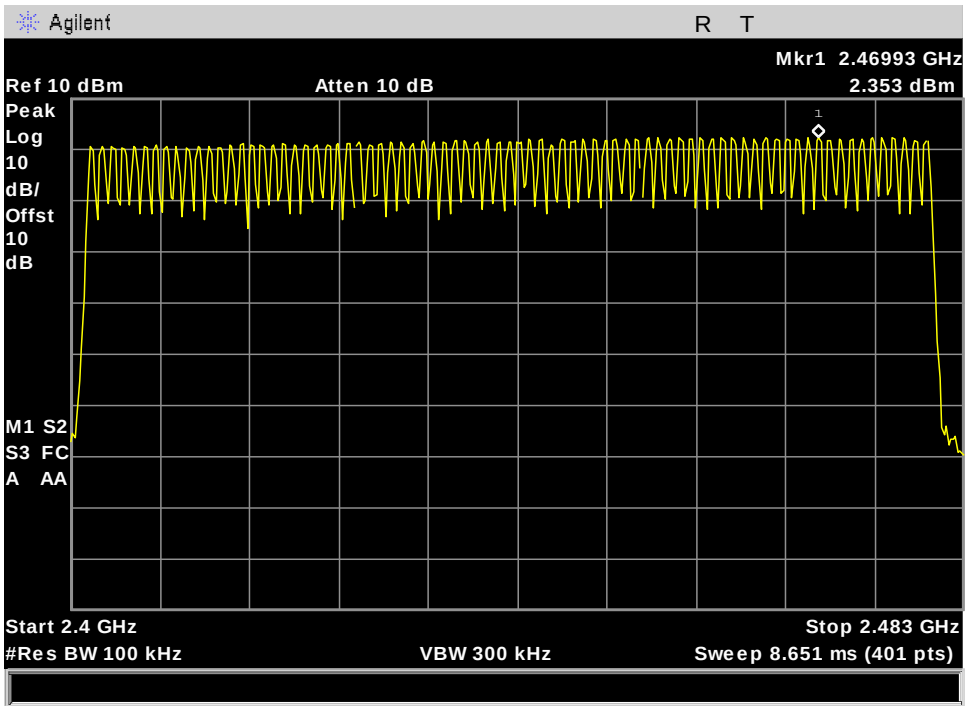

Figure 150: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1 hopping_reference level

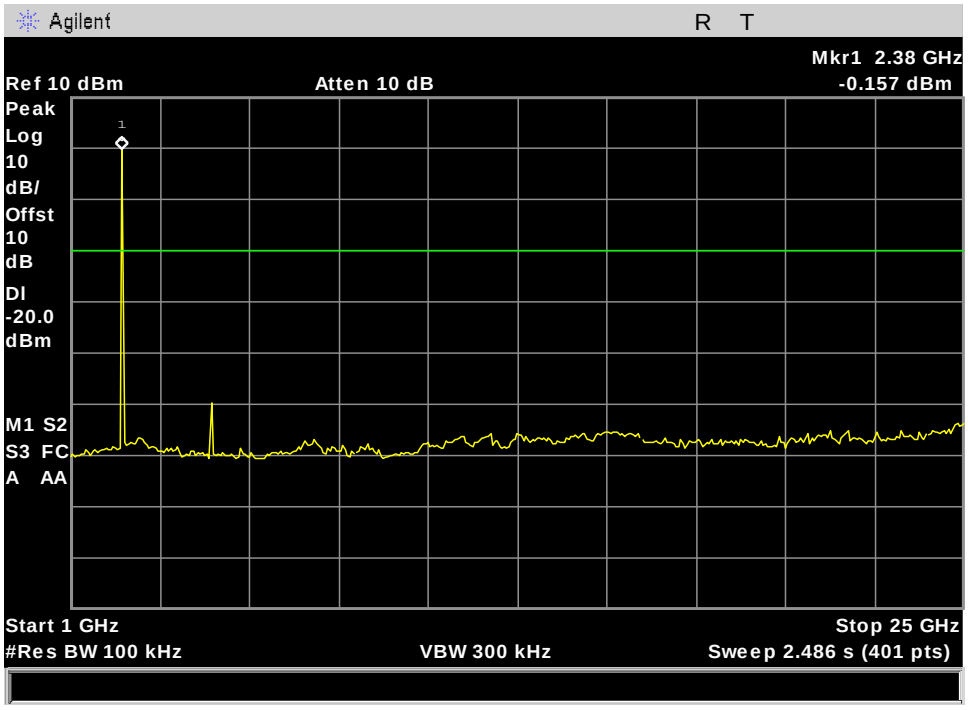

Figure 151: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2402_1-25GHz

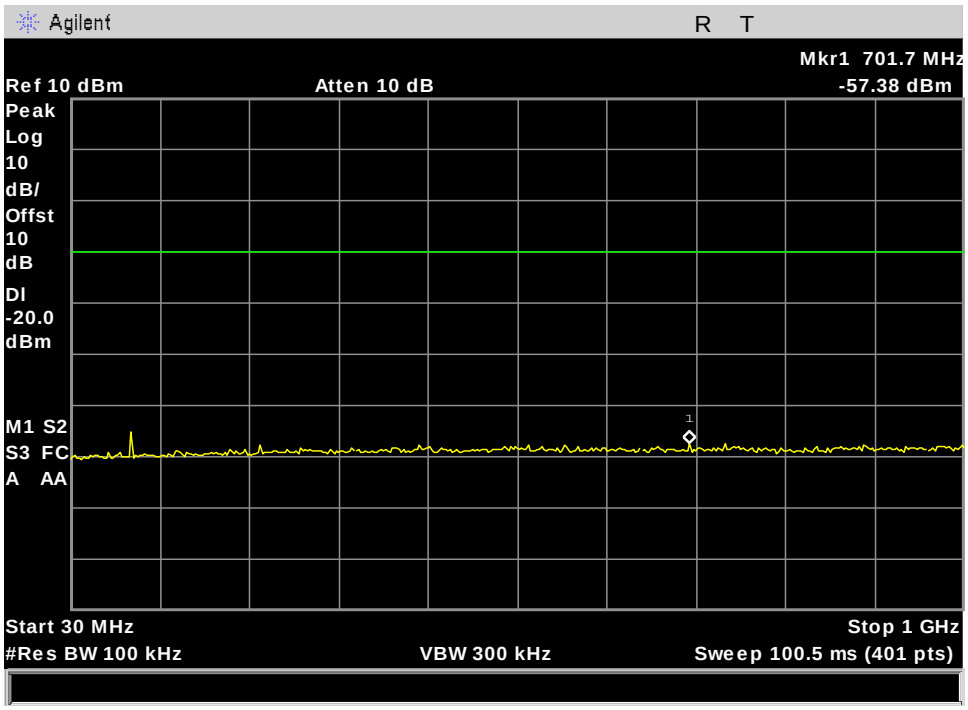

Figure 152: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2402_30-1000MHz

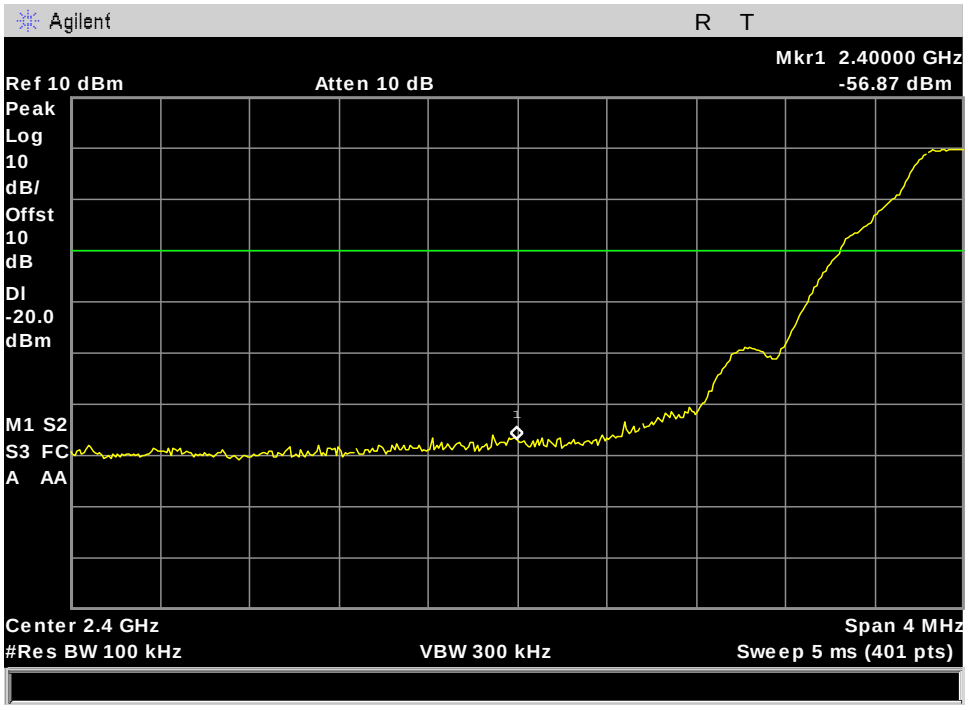

Figure 153: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2402_low band edge

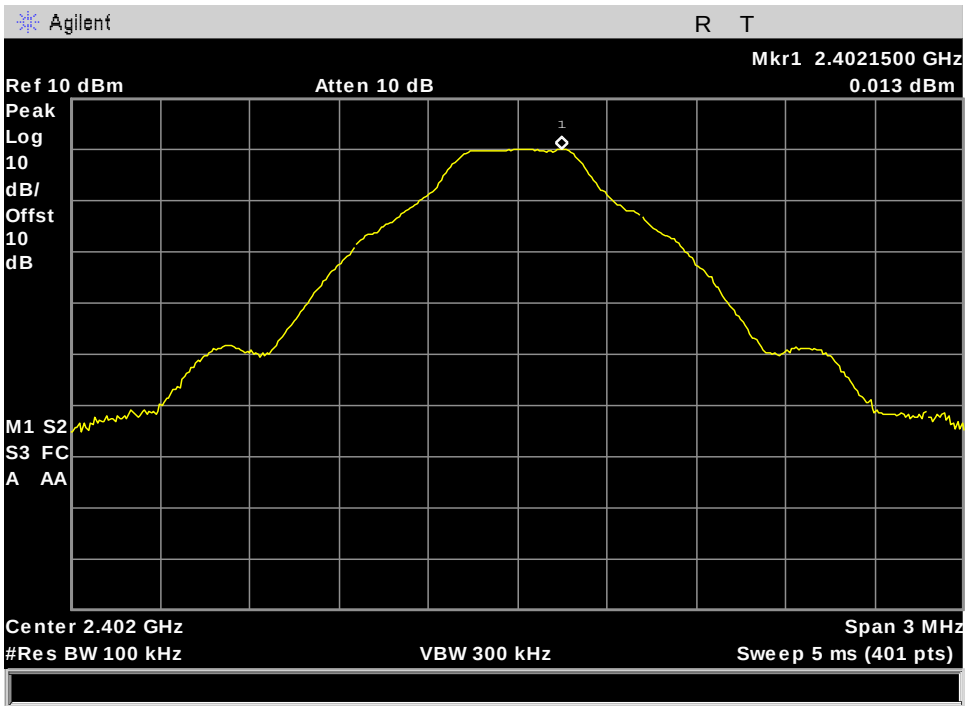

Figure 154: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2402_reference level

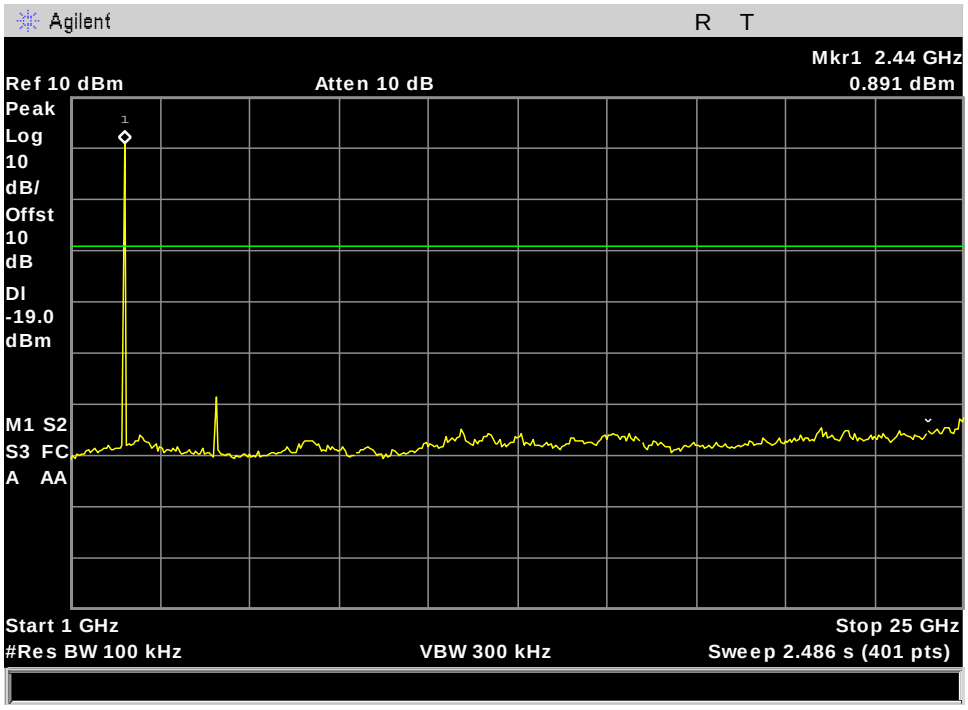

Figure 155: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2441_1-25GHz

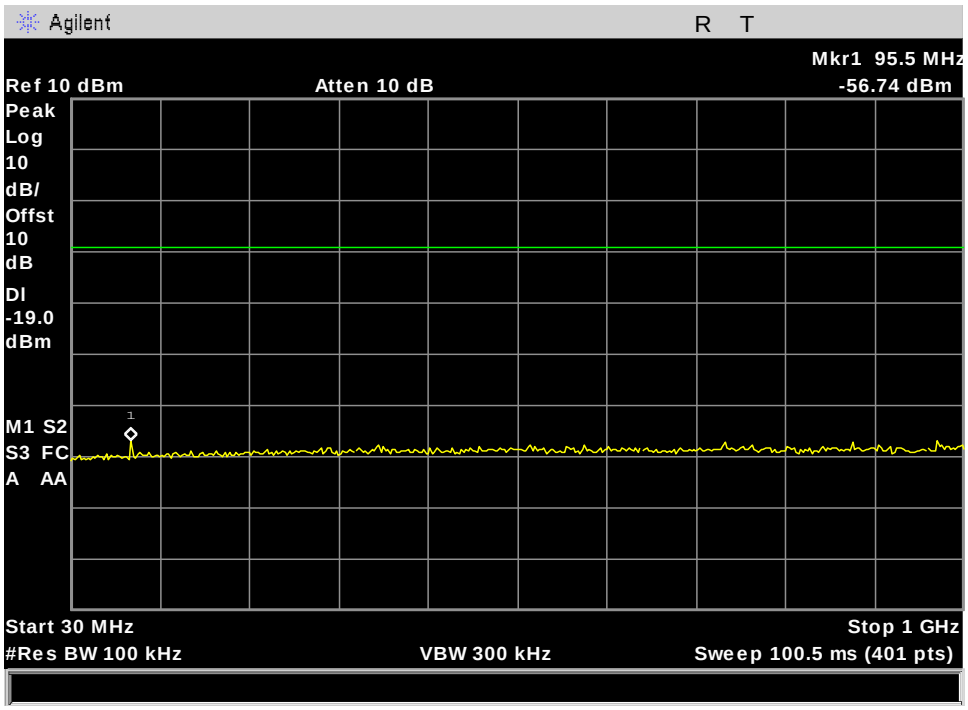

Figure 156: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2441_30-1000MHz

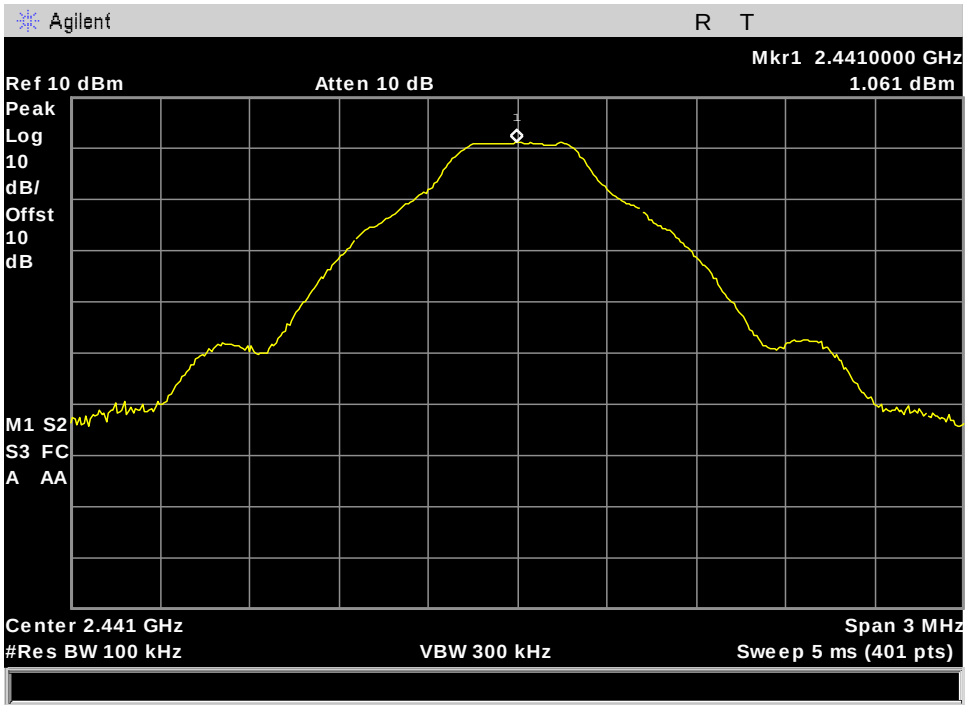

Figure 157: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2441_reference level

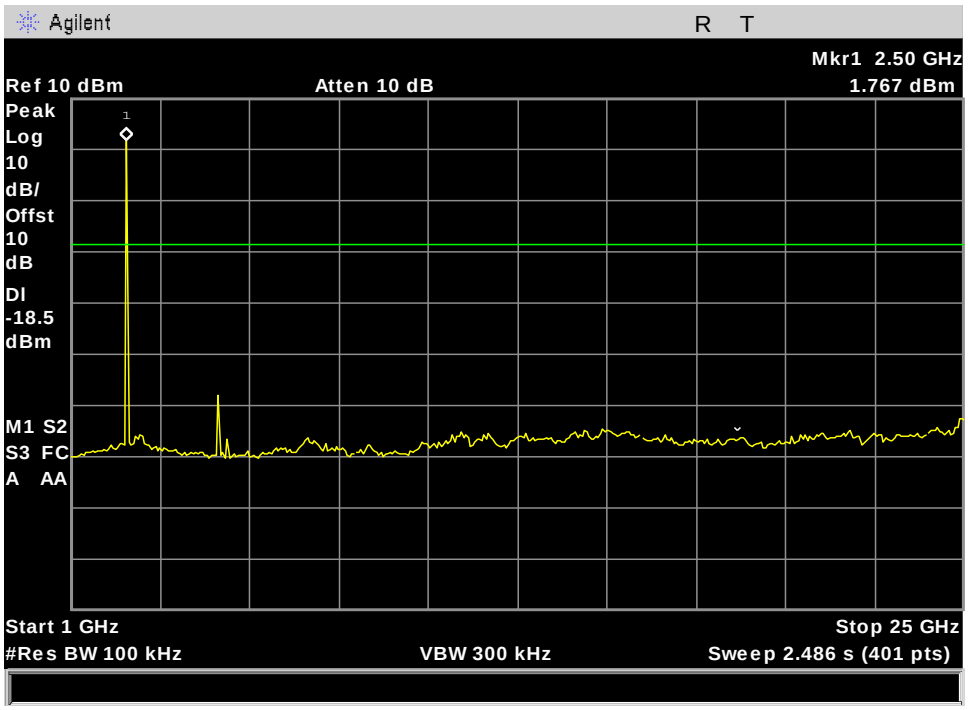

Figure 158: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2480_1-25GHz

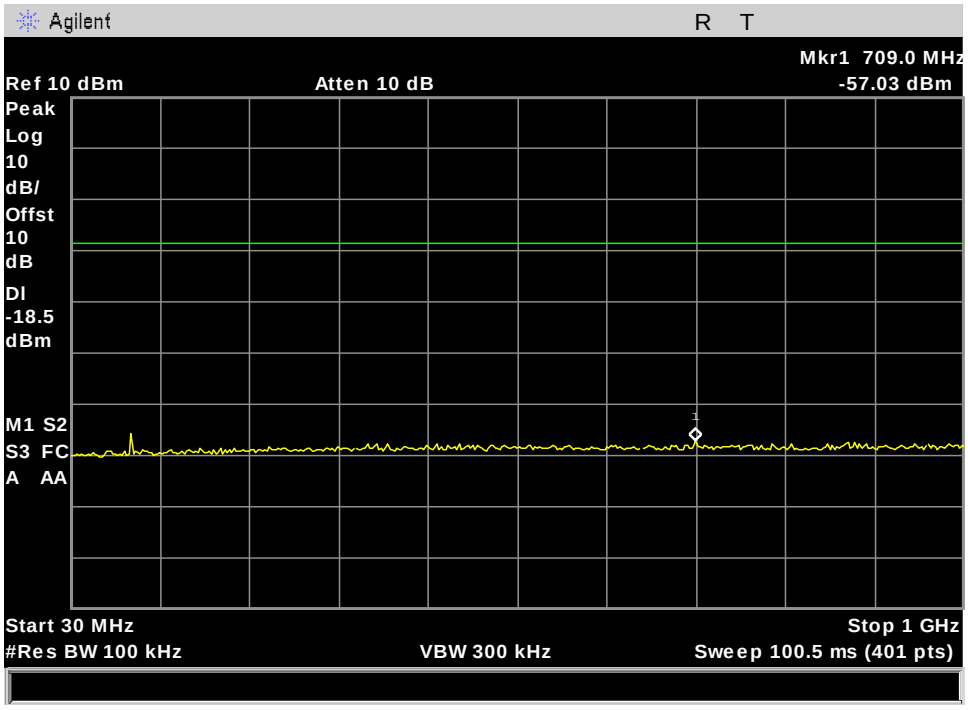

Figure 159: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2480_30-1000MHz

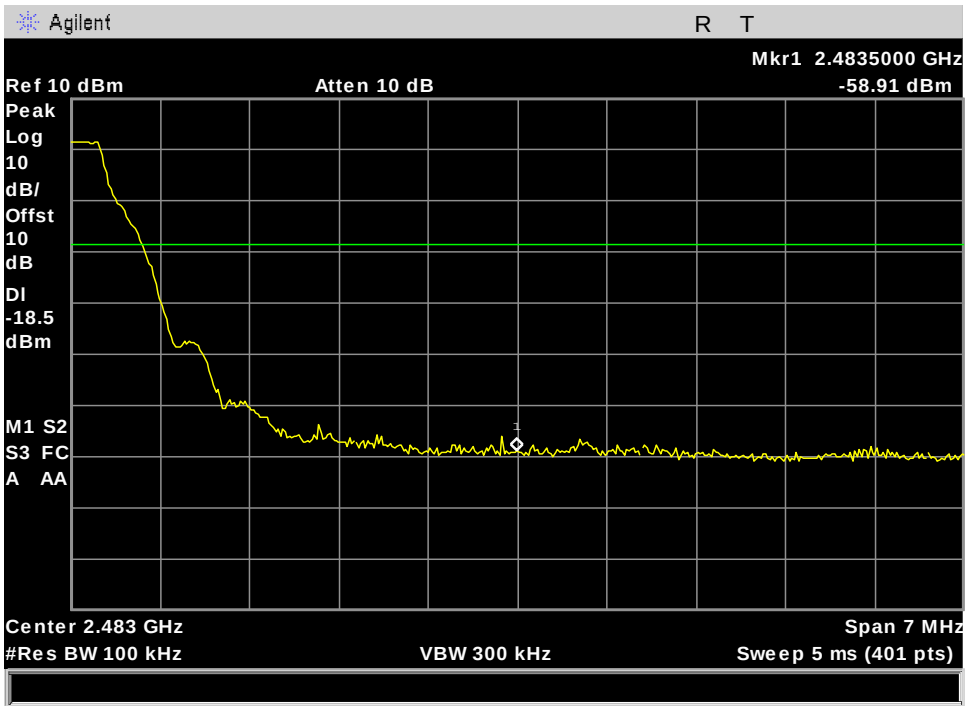

Figure 160: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2480_high band edge

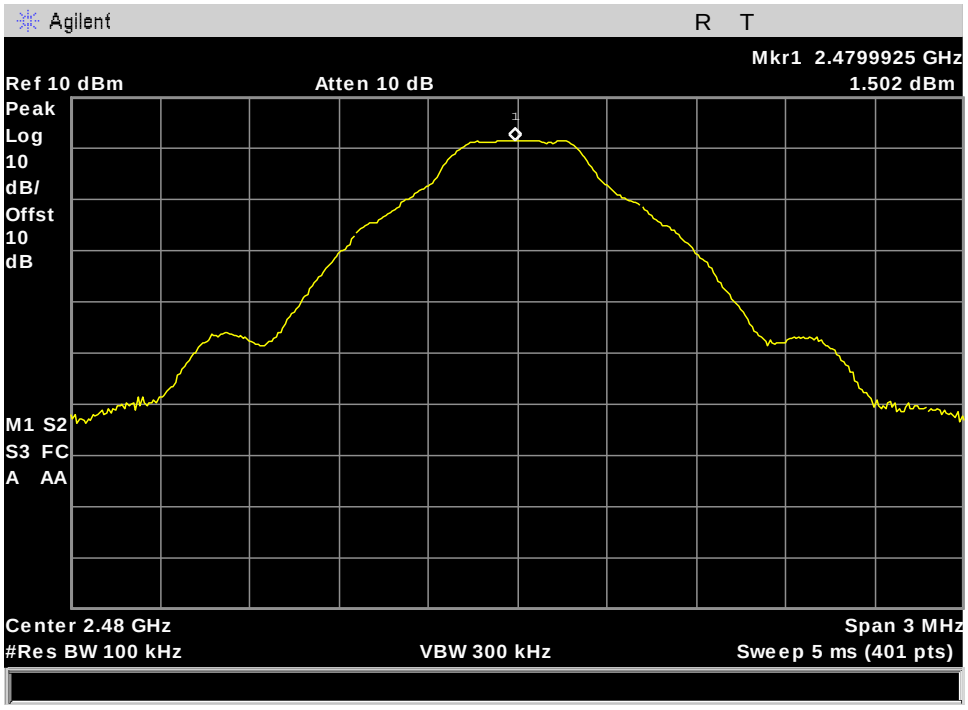

Figure 161: RF Conducted Spurious Emissions Requirements and Band Edge, 100k spurious_DH1_2480_reference level

Electromagnetic Compatibility Criteria for Intentional Radiators
§ 15.247(i) Specific Absorption Rate (SAR)
§ 2.1093 Radiofrequency radiation exposure evaluation: portable devices

RF Exposure Requirements: **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Remark: EUT is portable, SAR evaluation required.

Criterion: EUT is SAR compliant as per report: 467 FCC Rev A No Photos

Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

ASSET #	EQUIPMENT	MANUFACTURER	MODEL	LAST CAL	CAL DUE
1T4829	SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4407B	09/28/2018	03/28/2020
1T4565	LISN (24 AMP)	SOLAR ELECTRONICS COMPANY	9252-50-R-24-BNC	04/03/2019	10/03/2020
1T4504	SHIELDED ROOM	UNIVERSAL SHIELDING CORP	N/A	NOT REQUIRED	NOT REQUIRED
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	2/26/2020	8/26/2021
1T4409	EMI RECEIVER	ROHDE & SCHWARZ	ESIB7	1/4/2019	1/4/2021
1T4300B	SEMI-ANECHOIC 3M CHAMBER SVSWR	EMC TEST SYSTEMS	NONE	6/30/2019	12/30/2020
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	6/30/2019	6/30/2020
1T4751	ANTENNA - BILOG	SUNOL SCIENCES	JB6	5/2/2019	11/2/2020
1T4905	HORN ANTENNA	COM-POWER	AH-118	5/7/2019	11/7/2020

Figure 162: Test Equipment List

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

Certification & User's Manual Information

Certification & User's Manual Information

M. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

(i) Compliance testing;

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

§ 2.901 Basis and Purpose

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

Certification & User's Manual Information

§ 2.948 Description of measurement facilities.

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

Certification & User's Manual Information

1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

End of Report